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IS THE U.S SUBPRIME CREDIT CRISIS A PREDICTABLE SURPRISE?

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This thesis is dedicated to the glory of God and to our expected addition to the Osibanjos', my jewel Oluwatamiloreeyina.

Abstract

This thesis is an assessment of the possibility to predict the United States subprime crisis in order to determine whether it was a predictable surprise. Different methods were explored. A discrete-choice model is estimated with an underlying intuition that is very simple. The results suggest that the subprime crisis though a complex phenomenon can be predicted by just using a few variables. I then turn to a descriptive analysis that first focuses on macroeconomic fundamentals and then a comparison of this crisis with previous financial crisis was also examined which proved that the subprime credit crisis was no different than other financial crises of the past. The final conclusion is that the subprime credit crisis was a predictable surprise which government should have seen coming and made moves to avert it. Though the exact timing per se cannot be predicted, but the vulnerability –that is a high probability that a crisis can occur – can be detected and should have been detected. Further research on whether the subprime crisis would lead to a twin crisis should be carried out and also if my parsimonious model can be used in predicting a financial crisis for countries like the United Kingdom, Spain etc that are also experiencing falling housing prices with the United States are also vulnerable to the credit crisis.

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Chapter 1

1.1 INTRODUCTION

Prevention of an adverse event or extreme events often depends on our ability to predict the crisis in advance so that policy makers can device means or strategies to avoid economic downturn. One such catastrophe which may require policy intervention is the U.S Sub-prime crises. The crisis has led to and can now be properly labelled as the Banking /credit crises[1] of 2007 and 2008. In retrospect, the events that have led to this crisis clearly stands out as the most severe financial shock witnessed in decades with visible damage not only to the financial sector but also extending to the real economy as well. Indeed, the cost of this credit crisis in economic, financial and human terms has already reached staggering proportions and even after 12 months, substantial vulnerabilities still exist and remain. Learning how and why such crises occur, is thus of extreme importance. And much more important still: if it is possible to predict that given the current situation a crisis will occur, it might theoretically be possible to prevent it. This paper is an attempt to evaluate this possibility to predict the sub-prime credit crisis that is currently affecting the worldwide economy from the United States.

The write-downs experienced by large integrated financial intermediaries – most especially in United States and Europe – are also of staggering proportions. It is probably fair to say that, as late as the summer of 2007, virtually most of the top institutions imagined that as July of 2008 according to the CRMPG III report[2], financial sector write-offs and loss provisions would approach $500 billion, even as the meter is still running. The International Monetary Fund (IMF) has warned that the potential losses from the credit crunch will reach a staggering $1 Trillion according to a report by BBC (8 April 2008).[3] Although most of the starting capital positions of the affected institutions were relatively strong and even more so, some of them have been able to raise very large amounts of additional capital in recent months. It is noteworthy to mention that due to the crises, the biggest investment banks on

[1] "Banking crises" is an extremely difficult term to define. Calomiris and Gorton (1991) have discussed how much of the empirical work literature on banking crisis is in fact turns on the precise definition used. Generally, these crises feature either "runs" on banks or the closure, merger or substantial government involvement in major financial institutions.

[2] A report titled "Containing Systematic Risk: The Road to Reform" to Treasury Secretary Henry Paulson and Financial Stability Forum Chairman Mario Draghi on Aug 6, 2008. The report focuses on how the private sector can work to "reduce the frequency and/or severity of future financial shocks while recognizing that such future shocks are inevitable." The report's recommendations are being supported by several large investment banks.

[3] A report by an Economics reporter for BBC News Steven Schifferes.
http://news.bbc.co.uk/2/hi/business/7336744.stm

Wall Street are no more. The last remaining investment banks, Goldman Sachs and Morgan Stanley, were forced to seek sanctuary by converting into bank holding companies after the trampling of Lehman Brothers turned into a full-scale run on the industry.[4]

Even with the benefit of hindsight, there seems to be a large and troubling question as to the way in which events unfolded beginning in the July and August interval of 2007. Which are, why are so many, in both the official and private sectors, so slow in recognizing that the economy is on the cusp of a financial crises of this magnitude that is being experienced today? Possible explanation to this effect is long. Could it be that the underlying complexity and risk characteristics of certain financial instruments were so opaque that perhaps some of the most sophisticated financial institutions in the world and their supervisors were simply caught off guard? Another plausible explanation lies in the fact that the preceding eight to ten years had witnessed multiple financial disturbances with multiple reasons – all of which ended up resolving itself with little damage and limited contagion. These experiences undoubtedly might have given rise to a false sense of security that the emerging problems of the summer of 2007 would ultimately resolve themselves with little or no systematic change.

Another very important aspect of this crisis is the fact that two hedge funds and one of the investment banks Goldman Sachs escaped the bullet. As the *Times* of London noted in a Nov. 22, 2007, article, "Late last year, as the housing market motored along, David Viniar, Goldman's chief financial officer, called a 'mortgage risk' meeting in his 30th-floor Manhattan office. After the meeting, the bank's senior employees concluded that the mortgage lending industry was making a growing number of loans that borrowers could not possibly repay. So the bank decided to reduce its holdings of mortgages and related securities and to insure against losses on its remaining portfolio." Would we say that the bank saw the impending crisis and we can therefore take it that the subprime crisis was predictable?

In this thesis – in order to determine whether the credit crisis was a predictable surprise, the descriptive choice and the descriptive method would be used. First a logit model is estimated. I then turn to a descriptive analysis of macroeconomic fundamentals. This yields a very solid conclusion that the subprime credit crisis was indeed predictable and the path of this crisis was no different from past financial crisis in the developed economies that had happened before now. Although the exact timing would probably be impossible to predict, but the

[4] http://www.economist.com/daily/news/displaystory.cfm?story_id=12294688

vulnerability to the crisis had a "big handwriting on the wall" that should have been spotted long before now and it could have been avoided altogether.

The rest of this paper is organized as follows: In Chapter 2, I attempt to answer the following questions: What exactly is a predictable surprise? How did the subprime crises start anyway? I also briefly describe the theoretical models. Chapter 3 focuses more on the financial data and the methodology I want to employ in seeing if this crisis is actually predictable. I will describe and present the result of the discrete-choice regression. In Chapter 4, I make use of a more descriptive analysis that focuses more on macro-economic fundamentals by looking at how some macroeconomic variables behave just before the crises and compare it to the behaviour of the variable over time on average before the crises started. In addition, I also analyze whether the credit crisis of 2007 in the United States could have been predicted by finding similarities with the "big five financial crisis" in the industrialized nations of Sweden, Finland, Japan, Norway, Mexico and other financial crisis of the past. Finally in Chapter 5, I summarised and then concluded on whether the sub-prime credit crisis was indeed a predictable surprise based on our model developed in Chapter 3 and our descriptive analysis in Chapter 4.

Chapter 2

2.1 Background to the Subprime Crisis

Crouchy and Turnbull (2008) examined how the credit crises all started. Interest rates have been relatively low for the first part of the decade[5]. This low interest rate environment has spurred increases in mortgage financing and substantial increases in house price. [6] It encouraged investors to seek instruments that offer yield enhancement. Subprime mortgages offer higher yields than standard mortgages and consequently have been in demand for securitization. The demand for increasingly complex structured products such as collateralized debt obligations (CDOs) which embed leverage within their structure exposed investors to greater risk of default, though with relatively low interest rates and rising house prices, this risk was not viewed as excessive.

Prior to 2005, subprime mortgage loans accounted for approximately 10% of outstanding mortgage loans. By 2006, subprime mortgages represented 13% of all outstanding mortgage loans with origination of subprime mortgages representing 20% of new residential mortgages compared to the historical average of approximately 8%.[7] Subprime borrowers typically pay 200 to 300 basis points above prevailing prime mortgage rates. Borrowers who have better credit scores than subprime borrowers but fail to provide sufficient documentation with respect to all sources of income and/or assets are eligible for Alt-A loans[8]. In terms of credit risk, Alt-A borrowers fall between prime and subprime borrowers.[9]

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[5]The Fed funds rate was 1% in June 2003. It started to slowly increase in June 2004, and was 5.25% by June 2006. It was reduced to 4.75%, September 18, 2007.

[6] In the U. S. 50 million, or two-thirds of homeowners currently have mortgages, with 75.2% being financed with fixed rate mortgages and the remaining 24.8% with adjustable rate mortgages (ARMs). These figures come from the Mortgage Bankers Association, August 15, 2007.

[7] Subprime loans grew from $160 billion in 2001 (or 7.2% of new mortgages) to $600 billion in 2006 (or 20.6% of new mortgages)

[8] Alt-A loans are loans the ones you get when you don't submit all the documentation that would be required to qualify for a straight loan. These are usually chosen by people who have unsteady sources of income—or simply have too little documented income to qualify for a straight loan for the house they want to buy. They are considered riskier than prime but less risky than sub-prime.

[9] It is important to distinguish between a prime and a subprime borrower in order to define the latter properly. There are two lending worlds out there: the prime market, people who can get loans at the best rates, and the subprime market, people who are offered loans with higher interest rates than prime or "choice" customers. Furthermore, the subprime lending market allowed many credit-challenged people and those without a credit history to buy homes. Nevertheless within the subprime industry they are businesses which prey on these riskier borrowers. They intentionally burden their customers with loan terms that make it difficult for them to ever join the prime market.

During the same period, financial markets have been exceptionally liquid, which has fostered higher leverage and greater risk-taking. Spurred by improved risk management techniques and a shift by global banks towards the so-called "originate and distribute" business model, where banks extend loans but then distribute much of the underlying credit risk to end-investors, financial innovation has led to a dramatic growth in the market for credit risk transfer (CRT) instruments. Over the past four years the global amount outstanding of credit default swaps has multiplied more than tenfold,[10] and investors now have a much wider range of instruments at their disposal to price, repackage, and disperse credit risk throughout the financial system.

CDOs of subprime mortgages are the CRT instruments at the heart of the current credit crisis, as a massive amount of senior tranches of these securitization products have been downgraded from triple-A rating to non-investment grade. The reason for such an unprecedented drop in the rating of investment grade structured products is the significant increase in delinquency rates on subprime mortgages after mid-2005, especially on loans that were originated in 2005-2006.

The delinquency rate for conventional prime adjustable rate mortgages (ARMs) peaked in 2001 to about 4% and then slowly decreased until the end of 2004, when it started to increase again. It was still below 4% at the end of 2006. For conventional subprime ARMs, the peak occurred during the middle of 2002, reaching about 15%. It decreased until the middle of 2004 and then started to increase again to approximately 14% by the end of 2006, according to the Mortgage Bankers Association.[11] During 2006, 4.9% of current home owners (2.45 million) had subprime adjustable rate mortgages. For this group, 10.13% were classified as delinquent[12], this translates to a quarter of a million home owners. At the end of 2006, the delinquency rate for prime fixed rate mortgages was 2.27% and 10.09% for subprime.[13]

Why did delinquencies rise substantially? There are four reasons why delinquencies on these loans rose significantly after mid- 2005. First, subprime borrowers are typically not very creditworthy, often highly levered with high debt-to-income ratios, and the mortgages

[10] According to Bank for International Settlements (BIS) the notional amount outstanding of CDSs (Credit Default Swaps) was $43 trillion by end of June 2007 while it was only $14 trillion at the end of 2005. However, according to ISDA, the net exposure to the banking system is "only" $1 trillion after netting.

[11] Doms, Furlong and Krainer (2007) find a negative correlation between house prices appreciation and Subprime delinquency rates. They also show that the rate of change in the price appreciation affects the delinquency rate.

[12] Delinquency is defined by the Mortgage Bankers Association as having one or more payments over due.

[13] These figures are given in the press release of the Mortgage Bankers Association (March 13, 2007).

extended to them have relatively large loan-to-value ratios. Until recently, most borrowers were expected to make at least 20% down payment on the purchase price of their home. During 2005 and 2006 subprime borrowers were offered "80/20" mortgage products to finance 100% of their homes. This option allowed borrowers to take out two mortgages on their homes. In addition to a first mortgage for 80% of the total purchase price, a simultaneous second mortgage, or "piggyback" loan for the remaining 20% would be made to the borrower.

Second, in 2005 and 2006 the most common subprime loans were of the so called "short-reset" type. They were the "2/28"or "3/27" hybrid ARMs subprime for which the interest rate initially charged is much lower than standard mortgage rates, but after a two to three year period, it is typically reset to a much higher rate. These loans had a relatively low fixed teaser rate for the first two or three years, and then reset semi-annually to an index plus a margin for the remaining period. A typical margin was 400 to 600 bps. Short-term interest rates began to increase in the U.S. from mid-2004 onwards. However, resets did not begin to translate into higher mortgage rates until sometime later. Debt service burdens for loans eventually increased, which led to financial distress for some of this group of borrowers. To make matters worse, $500 billion in mortgages will reset in 2008.

Third, many subprime borrower had counted on being able to refinance or repay mortgages early through home sales and at the same time produce some equity cushion in a market where home prices kept rising. As the rate of U.S. house price appreciation began to decline after April 2005 the possibility to refinance early was pushed further into the future and many subprime borrowers ended up incurring higher mortgage costs than they might have expected to bear at the time of taking their mortgage.[14]

Fourth, the availability of subprime mortgages was amplified by investor demand for higher yielding assets. This boosted the demand for residential mortgage-backed securities (RMBS) and CDOs containing mortgage-backed securities (MBS) and CDO tranches, which offer higher returns compared to those available from corporate or sovereign credit. The supply of

[14] The economy started to witness some dramatic changes. First, as Federal Reserve increased the fed funding rate, mortgage rates started to increase and second, house price appreciation decelerated. Different factors cause delinquency in the mortgage market and this includes but not limited to unemployment due to job loss, unanticipated medical expenses, divorce and rising mortgage expenses. House price can also affect the default decision. If house prices are falling, it can affect the decision in two ways (1) It limits the ability to refinance and (2) it can cause the home owner's equity to become negative if the equity stake ab-initio was small, and is often the case with subprime mortgages. (See the report from the Office of Federal Housing Enterprise Oversight – Aug 30, 2007)

subprime assets adjusted to this higher demand aided by the application of excessive loose credit standards by mortgage originators.[15] Some mortgage borrowers have ended up with subprime mortgages, even though their credit worthiness qualifies them for lower risk types of mortgages, others ended with mortgages that they were not qualified to have.[16] The accuracy of information in mortgage applications slipped. It has also spurred an increase in illegal lending practices and massive fraud.[17] The results of these declining standards and dubious practices in underwriting over the last three years have manifested themselves in greatly increased delinquency rates for mortgages originated during 2005 and 2006.

Traditionally, banks have financed their mortgage lending through the deposits they receive from their customers. This has limited the amount of mortgage lending they could do. In recent years, banks have moved to a new model where they sell on the mortgages to the bond markets. This has made it much easier to fund additional borrowing but it has also led to abuses as banks no longer have the incentive to check carefully the mortgages they issue.

[15] This issue was exacerbated by the decline in subprime mortgage rate starting in 2004 due to increase price competition. This coupled with the Federal Reserve increasing the interest rates, reduced the profitability of lending. In order to offset this decrease, some originators reduced standards – see Coy (2007). Evidence of loosening underwriting standards was also noted in 2005 in the Office of the Controller of the Currency 's annual survey of underwriting practices at national Chartered banks.

[16] See Morgenson (2007)

[17] Lenders were too willing to lend as evidenced by the creation of new types of mortgages, known generally as "affordability products" that required very little or no down payment, and very little or no documentation of a borrower's income, with the last one known as "liar loans". These type of loan accounted for 40% of the subprime mortgage issuance in 2006, an increase of 15% up from 25% in 2001. The state of the subprime market also attracted attention to industry practices in mortgage origination. The declining underlying standards and fraud is noted by Cole (2007) and Bernanke (May 17, 2007). Morgenson (2007) identified some of the techniques used by many of the lenders to increase subprime mortgage originations. These were very often not in the best interest of the borrower.

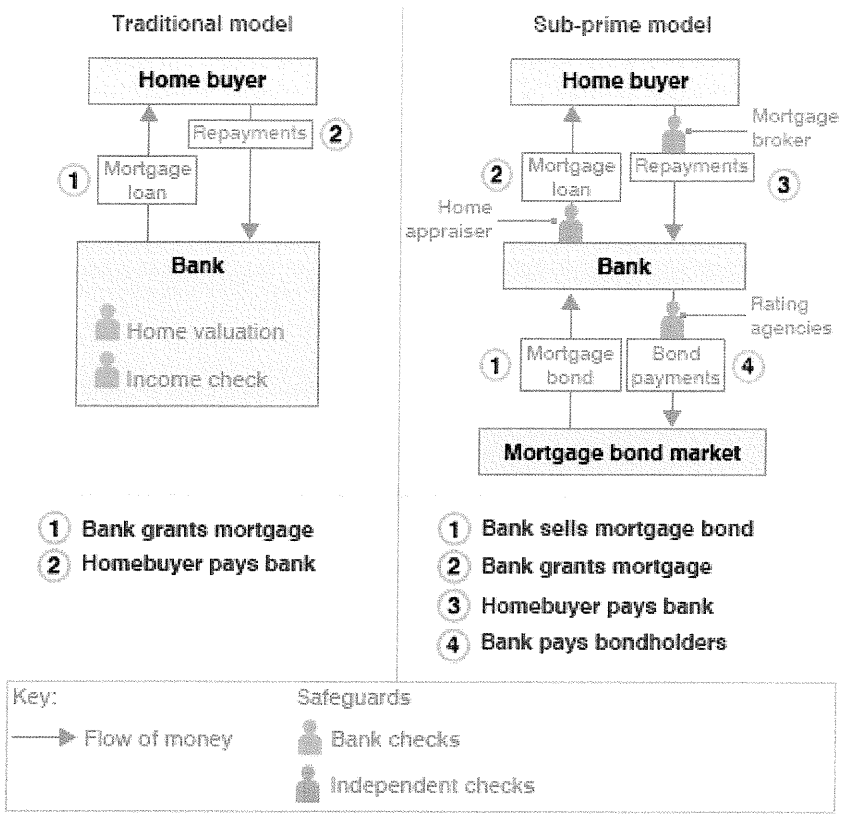

Figure 2-1- The new model of Mortgage Lending (BBC 2007)

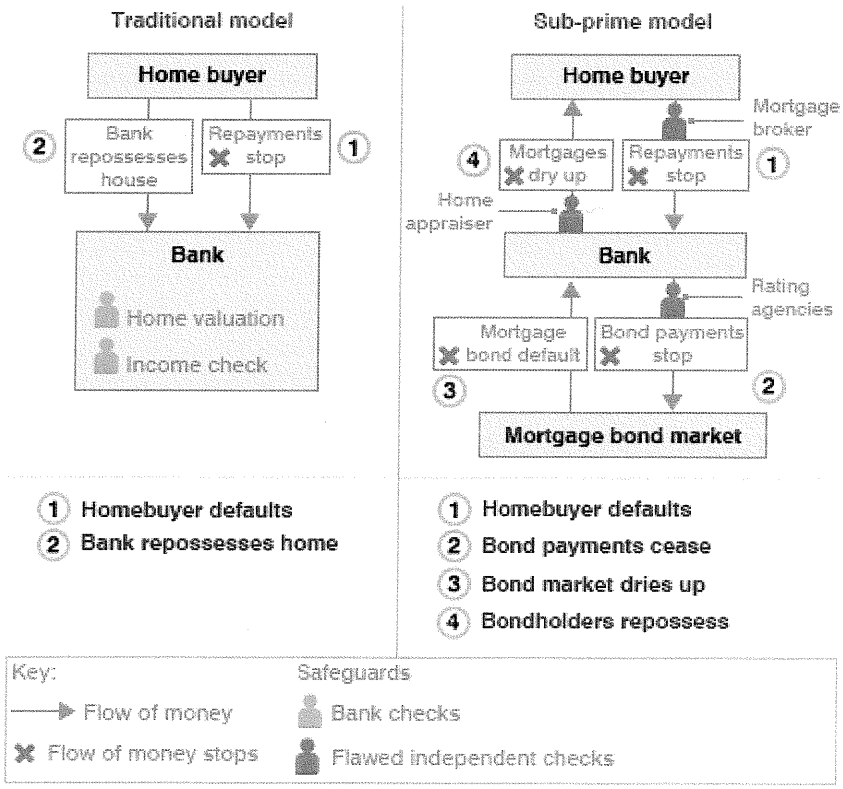

Figure 2-2 - – How it went wrong (BBC 2007)[18]

[18] BBC News Online (2007) (read 17.04.2008): <http://news.bbc.co.uk/2/hi/business/7073131.stm

2.2 Literature Review

This paper draws from two lines of literature. The first line is from the growing body of research on the psychology of extremes. The second line focuses on the performance and modelling of mortgages and specifically the delinquency of mortgages.

2.2.1 What is a predictable Surprise?

The topic of predictable surprises is covered in the text by Bazerman and Watkins (2004). This same text has been the motivation for writing this thesis. In the preface the authors ask "Why must a problem escalate into a full-blown crisis before costly corrective action is finally taken?" (pg.ix). The idea is motivated by the US attacks of 9/11, which are considered not to be true surprises, but rather "predictable surprises." This approach to understanding crisis or extreme event contrasts with another aspect of psychology of extremes known as the black swans approach by Taleb (2004), whose focus is that we know *less* than we think about extreme events.

Bazerman and Watkins define a predictable surprise as "an event or set of events that take an individual or group by surprise, despite prior awareness of all of the information necessary to anticipate the events and their consequences" [19]. They assert that, although the US government did not know that four planes would be used to attack New York and Washington, it did have enough data to know of easily exploitable deficiencies in airline security. Thus the attacks were a surprise, since the US government did not know the date and the details. However, they were predictable since the crucial information on lack of airline security was readily available. Bazerman and Watkins (2004) also define unpredictable surprises, which are events for which there were was no advance information available. No one could have predicted these events, including natural disasters such as hundred year floods.[20]

A clear distinction between unpredictable surprises and predictable surprises is pointed out by Bazerman and Watkins (2004). For the latter, predictable surprises, six characteristics are put forth which can be found in big crises and catastrophes which have occurred recently where leaders neglected the warning signs.

[19] Bazerman and Watkins, 2004, Page 1

[20] Note that Bazerman and Watkins (2004) realize that there is a continuum of predictability: some extremes are completely foreseeable, while others are less so.

1. The first characteristic of predictable surprises is that leaders are informed about the problem and know that it requires a solution.

2. The problem is getting worse over time. Leaders are aware that the problem will not get fixed without corrective measures.

3. Immediate fixing of existing problem will cause some costs at present, however, the benefits of actions and costs such as "a reduction of the likelihood and magnitude of events[21]" will be postponed or even will not be seen at all. As far as benefits are not obvious or tangible, leaders and citizens are reluctant to spend resources at present for something in the future that may not even happen.

4. The forth characteristic is related to the third and implies that leaders are reluctant to bear any costs because the benefits are not obvious and they know that they will not get any credit for preventing a potential disaster. Citizens don't think about possible catastrophes and can't imagine its magnitude and impact and will hence not give credit to the actions. Leaders therefore lack motivation to react since no reward for the action can be expected.

5. It is natural for humans to keep status quo when everything is fine and the system still functions. This happens because people tend to have positive illusions regarding the future and refuse to get some losses and harm now in a small portion even for a greater profit in the future. People tend to believe that a problem is not large, that it can solve itself and it will not lead to a disaster. This trait of human nature puts an obstacle for fundamental changes and only short-term solutions and decisions to improve incrementally are usually considered.

6. There are always individuals or organizations that benefit from status quo of decision-makers and governments. They lobby their interests and corrupt leaders. Even if the society is desperate for a change and decision from the government, small minorities can block a reform for their self-interests.

If a problem meets the above presented characteristics and no decision is made to act upon them, a crisis may be the result which qualifies as predictable surprise. In relation to the subprime / banking crises of 2007, did this characteristics manifest?

[21] Ibid, Page 6

According to Watkins[22], the contributing causes of the subprime collapse are clear in hindsight.

To avoid damage to the economy following the collapse of the Internet bubble in 1999, the U.S. Federal Reserve lowered interest rates which, in turn, lowered mortgage rates. The rate for 30-year, fixed-rate mortgages in the U.S. declined from 8.25% in January, 2000, to a low of 5.25% in January, 2003, and remained at low levels not seen since the 1960s for several years.

• A resulting surge in investment in housing, speculative and otherwise, helped drive median housing prices in the U.S. from $170,000 in 2000 to $240,000 in 2005. The resulting "equity cushion" permitted homeowners to increase their borrowing and encouraged still more speculation, creating a feedback loop.

• Securitization of mortgages into collateralized debt obligations (CDOs) decoupled mortgage originators (brokers and others) from the credit risks of the loans they were writing. At the same time, U.S. investment law shielded sellers of these securities from the legal consequences of fraud by originators. This introduced corrosive conflicts of interest into the system.

• The lure of easy money, creativity in the design of subprime mortgages (e.g., various forms of adjustable-rate mortgages with low initial payments), the inability of borrowers to fully understand the consequences of what they signed up for, and laxness in regulatory oversight fed a dramatic surge in subprime lending. A *Wall Street Journal* analysis has shown that the number of subprime mortgages written in California alone increased from 273,000 in 2004 (11.8% of total mortgages) to 573,000 in 2006 (29.4% of total)[23].

• Mortgage brokers wrote loans of increasingly poor quality, including many that were apparently fraudulently obtained. In another conflict of interest, appraisers, whose livelihoods depended on getting work from front-line lenders and brokers, colluded in fraud by making higher-than-justified assessments of home prices.

• The risk of the CDOs based on these mortgages rose dramatically. Rating agencies, for reasons not yet fully understood, systematically underestimated the risks associated with these instruments.

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[22] http://www.businessweek.com/managing/content/dec2007/ca20071213_764745.htm
[23] Ibid.

• The inevitable first wave of defaults and foreclosures eventually took hold, triggering the collapse. (Another, potentially larger wave of defaults triggered by upward resetting of rates on ARMs may be averted by government-led efforts to prevent interest rate rises.)

• Virtually all the major investment banks were trapped by the magnitude of their investments, but also by the herd mentality (the formal term is "a collective action problem") engendered by short-term, relative returns criteria that are used to evaluate their performance. In a July 7, 2007, interview with the *Financial Times*, former Citigroup CEO Charles Prince III unknowingly uttered his epitaph: "When the music stops, in terms of liquidity, things will get complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing."

• When the bubble burst, the banks, to varying degrees, were caught with their pants down. Citigroup's massive exposure cost the dancing CEO his job. Morgan Stanley anticipated the collapse but not the breadth of its impact on CDOs, and it placed the wrong bets. Total losses for investment banks have been estimated to be as high as $300 billion. Of the big investment banks, only Goldman Sachs really dodged the bullet".

According to him, all these were quite clear in retrospect but what's the evidence that the subprime meltdown was a predictable surprise? First, as early as 2003, some farsighted observers were raising concerns about whether the subprime market was built, if you will pardon the pun, on a house of cards. Prem Watsa, CEO of Fairfax Financial Holdings, commented in the company's 2003 annual report, for example, that, "We have been concerned for some time about the risks in asset-backed bonds, particularly bonds that are backed by home equity loans, automobile loans or credit card debt.... It seems to us that securitization...eliminates the incentive for the originator of the loan to be credit sensitive.... There is $1.0 trillion in asset-backed bonds outstanding as of December 31, 2003, in the U.S.... What happens if we hit an air pocket?" Well we certainly have the answer.

Second, we have the wonderful example of Goldman Sachs' recognition of the impending collapse and move to limit its exposure. As the *Times* of London noted in a Nov. 22, 2007, article, "Late last year, as the housing market motored along, David Viniar, Goldman's chief financial officer, called a 'mortgage risk' meeting in his 30th-floor Manhattan office. After the meeting, the bank's senior employees concluded that the mortgage lending industry was making a growing number of loans that borrowers could not possibly repay. So the bank

decided to reduce its holdings of mortgages and related securities and to insure against losses on its remaining portfolio."

That Goldman got it right demonstrates beyond a shadow of doubt that the subprime collapse was a predictable surprise. How galling it must have been to the leaders at Citigroup, Morgan Stanley, UBS, and the others that Goldman didn't dance off the cliff with. They would have been able to argue that "no one could have seen it coming." A fund manager not employed by Goldman told Watkins that a Goldman representative informed him that they were seeing unexplained anomalies in their models more than two years ago and began to prepare for the consequences[24].

Lest Goldman is lauded too highly however, there was the need to ask whether they continued to sell products based on subprime mortgages even after they began to limit their own exposure or shorted subprime CDO products they had recently sold to clients. According to Watkins, there are lessons to be learnt from all of this. First that many surprises really are predictable – and it's not merely that they look that way in hindsight. Second, complexity, conflicts of interest, collective action traps are at the root of most predictable surprises. Due to this reason, we should not be surprised to see the financial markets blow up if:

1. Naive consumers are allowed to make highly complex financial decisions under the influence of sophisticated sellers. (Pension decisions associated with defined contribution plan is an area that immediately comes to mind.)

2. There is an allowance for pernicious conflicts of interest to take root and thrive in the financial system and there is no provision for sufficient, coherent regulatory oversight. Propriety trading and investment by investment banks are an example of this.

3. We continue to ensnare the people who invest money on our behalf in a collective action trap by judging them on short-term, relative performance criteria, rather than long-term sustainable ones.

There is the need to see what the other aspect of the psychology of extreme black swan by Taleb (2004) say as regards the predictability of the sub-prime credit crisis.

[24] Ibid.

2.2.2 Black Swans

Another interesting approach to extremes is due to Taleb (2004), who uses the term "black swan" to describe extreme or extraordinary events. Does the subprime crisis qualify as an extreme event? Taleb makes a distinction between 'mild' and 'wild' data. He seems to use mild to refer events that are close to normal distribution and wild to refer to heavy-tailed or perhaps even unidentifiable distributions.

Taleb (2004) defines "a black swan as an outlier, an event that lies beyond the realm of normal expectations. Most people expect all swans to be white because that's what their experience tells them; a black swan is by definition a surprise. Nevertheless, people tend to concoct explanations for them after the fact, which makes them appear more predictable, and less random, than they are. Our minds are designed to retain, for efficient storage, past information that fits into a compressed narrative. This distortion, called the hindsight bias, prevents us from adequately learning from the past."

According to Taleb[25] the current subprime credit crises is what he will refer to as "Gray swans". He said he has always been saying that banks have a tendency to sit on time bombs while convincing themselves that they are conservative and non-volatile. The Black Swan is a matter of perspective. A turkey is fed for 1,000 days - every day lulling it more and more into the feeling that the human feeders are acting in its best interest. Except that on the 1,001st day, the butcher shows up and there is a surprise. The surprise is for the turkey, not the butcher. Anyone who knows anything about the history of banking (or remembers the 1982 Latin American debt crisis or the 1990s savings and loan collapse) will tell you that the subprime crisis was so bound to happen. Banks are exposed to such blowups. Bankers have been the turkey, historically.

Various literatures on the performance of subprime mortgages have focused on prepayments, default and losses on outstanding defaulted balances. In general, loss severity tends to be higher for high-risk borrowers and high-risk property. Capozza and Thomson (2004) found that these losses tend to be larger even though subprime borrowers tend to sell the mortgage earlier than prime borrowers when it is less in the money to default. Alexander et al (2002) and Pennington-Cross (2003) also found that loans originated by third parties tend to default at elevated rates and that high cost borrowers are less responsive to changing interest rates.

[25] An interview with Taleb by CNN Money on how Wall street failed to anticipate the disaster. http://money.cnn.com/2008/03/31/news/economy/gelman_taleb.fortune/index.htm

Cowan and Cowan (2004) showed that for single subprime lender, risks tend to be higher for the higher cost segments in the market because the defaults are more highly correlated. For lower cost segments, such as A- and Alternative-A, subprime loans showed relatively low default correlation rates.

2.3 Delinquency

Traditional option based mortgage-pricing research includes three possible states for a mortgage – 1) current or active, 2) prepaid, or 3) defaulted.[26] This approach typically ignores the fact that lenders are usually not allowed to begin foreclosure proceedings until two payments are missed and the third one is due. There are several options available to lenders besides foreclosure in order to recover losses on defaulted loans and it can take a substantial period of time to complete a foreclosure. For example, the main feature of a ruthless default is that it makes financial sense because the mortgage is substantially larger than the value of the property. But, the relevant value of the property is at foreclosure, not when the first or even second payment is missed. The value of a future default can impact whether an "in the money" default today will be exercised.[27] For example, if house prices continue to drop in the future, the value of default will be larger than in the future, and the borrower will wait. In a stochastic framework, the larger the variance of house prices, the more value there may be in the future, so it is consistent for borrowers that are "in the money" to default to wait.

Ambrose et al (1997) examined the concept that the decision to stop making payments is determined by expected values of the property well into the future (at the foreclosure date) by introducing the option-pricing framework to the delay of foreclosure. The delay of foreclosure can be interpreted as an increase in the delinquency of the loan, but the model treats the delay of foreclosure as an exogenous variable and for that reason can be used to provide predictions about the probability of default given a foreclosure delay or delinquency time period. For example, the probability that a loan defaults and becomes delinquent is sensitive to the delay before foreclosure, the loan to value (LTV) ratio at origination, and the variance of house prices. Longer delays (more expected delinquency) and the LTV are associated with higher default probabilities. In general, as the variance increases the probability of default increases because the probability of negative equity has increased. The direction of this effect can change to negative when there is a very long delay until foreclosure or the lender has no recourse to recover any losses from other assets beyond the

[26] See Vandell (1995)
[27] See Kau and Kim (1994). They indirectly discussed this issue.

value of the house. This result is natural because in circumstances like these, there may be time for the house price to drop even further in the future making a future default more valuable and at the same time the borrower can receive free rent while the loan is delinquent (not paying any mortgage or monthly rent)[28]

Danis and Pennington Cross (2005) recognised that there are multiple states of delinquency and that these states are not independent of each other. But, in addition to the need to recognise the importance of various degrees of delinquency, any model must also recognise that loans can also prepay or default and that all these options are best viewed as competing risks. [29] They find that financial incentives strongly explain subprime loan outcomes. Borrower credit scores are robust predictors of delinquency, default and prepayment and LTV at origination is positively correlated with delinquency.

2.4 Theoretical Models

There are various theoretical bases for empirical work concerning crisis. Since the late 1970's economists have used different approaches for this end. Each "wave" of crises spawned its very own generation of theoretical models. Models in each generation all share similar assumptions based on the types of crises they were constructed to explain[30]. There is the I generation models that assert that the timing of a crisis is predictable which were based on the Latin American experience towards the late seventies and early eighties. Also there is the II generation models that say that crises are self-fulfilling, so the exact timing is not predictable. However, only countries in a "vulnerability zone", i.e. countries which have some weaknesses, can suffer an attack and empirical work can identify such weaknesses. This was based on the European and Mexican crises of 1992 and 1995. In addition, there are the III general models which focuses more on moral hazard ("too big to fail") and fiscal constraints would lead to the attack when the credibility of the bail out is questionable. This focused more or less on the Asian crisis of 1997. More recently a fourth generation is also being introduced. This constant creation of new models reflects the complexity and versatile structure of crises. One explanation is not just enough and each of the models that have been suggested has its own demerits and flaws.

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[28] Another school of thought looks at the time from a default, which is usually defined as being 90+ days delinquent, to resolution of the mortgage. Resolution could include many of the available loss mitigation tools used by lenders such as foreclosure, short sale, or even assumptions of the mortgage.

[29] They defined default as whenever the lender initiates foreclosure proceedings (the acceleration note) or the lender becomes the owner of the property which will be sold to help cover nay losses associated with the default and period of delinquency.

[30] The following is based on Breuer(2004) and Saxena(2004)

As Söderberg (2005) put it, in part as a response to the empirical troubles of the theoretical models, the so called "leading indicator" approach has been suggested. In this the researcher tries different means to measure a country's vulnerability to a crisis, or to predict one, using a set of indicators that reflects all possible causes of the theoretical models mentioned above. This approach thus tries to "side step" the theoretical literature, instead using some sort of underlying intuition in choosing its indicators. There are three main methods for doing this. (i) The signalling method tries to find a crisis "alarm clock" that goes off when one or more variables exceed a certain threshold. This approach was used by Kaminsky, Lizondo, Reinhart (1997), Kaminsky (1999) and Kaminsky, Reinhart (1999). Kaminsky et al (1997) applies signals approach to a traditional set of indicators to construct an "early warning system of currency crises". This approach starts with the selection of a set of variables based on economic priors and data availability and for each variable, the average level (or growth) in the period preceding a crisis is compared to that in tranquil periods. A value that exceeds a threshold before a crisis provides a warning signal. Given individual warning signals, a composite leading indicator can be constructed as a weighted average of these individual signals (see Kaminsky (1999)). The problem with this approach is the weights to be assigned. However, Berg and Patillo (1998) suggest multivariate probit model be used in assigning weights. In this procedure, both the crises indicator and the explanatory are transformed into dummies, larger or smaller than a given threshold. This procedure allows indicators to be ranked according to their ability to predict crises (noise-to-signal ratios). This should work well if there are sharp changes between crisis period episodes and periods of tranquillity. The problem with this procedure is that it ignores correlation between variables and it is difficult to access statistical significance of the results. (ii) The discrete-choice method instead uses binary regression models in order to estimate the probability that a crisis occurs given a set of indicators. This regression analysis (which uses the probit regressions was used by Frankel, Rose (1996) and Cross-section regressions adopted by Sachs et al (1996) and Johnson et al (2000). A crises indicator is modelled as a zero-one variable and the explanatory variables are not transformed into dummy variables, however, but are usually included linearly. The probit function ensures that the predicted outcome of the model is always between zero and one. And finally the third method is a more descriptive analysis of different case studies (iii), sometimes by creating a statistical model but often by non-quantitative evaluations of a country's situation.

There is also the event study which was adapted by Eichangreen et al (1994). The event study starts with the selection of a set of variables based on economic priors and data availability and for each variable; its behaviour during crises and pre-crises periods is compared with its behaviour during a non-crises or tranquil period in the same group of countries used. Alternatively, a control group of countries, where no crises have occurred, can be composed and informal visual comparison and various parametric and non-parametric tests are used to assess systematic differences in behaviour.

A lot of empirical and theoretical considerations have been written regarding the causes of foreclosure and why mortgages are delinquent. This thesis seeks to examine if the sub-prime credit crises was actually predictable relying purely on available public financial data.

Chapter 3

This section provides us with a binary response approach to the problem of predicting the subprime credit crisis. The subprime credit crisis can be regarded as an extreme event. There are two important aspects that we need to consider. The first aspect of international extremes is that they are often relatively infrequent. The second aspect is that such events are often binary or dummy variables – they either happen or they do not. In order to handle this, we will be using an extension of OLS technique which takes the shape of a logit model.

Another way of trying to estimate the likelihood of extreme event is attributable to the extreme value theory. In order to estimate the likelihood of an extreme event, the answer will depend on what we know about the distribution of the data. If we are fairly certain that the data is normally distributed for example, then we can just look up the probabilities in statistical tables. And even if we do not know the distribution, but believe the data to have a mean μ and finite variance σ^2, we can use Chebychev's rule, which places bounds on the likelihood of extreme events in the following way:

$$Pr[x - \mu \geq k\sigma^2] \leq \frac{1}{k^2}$$

In a situation where we have no idea about the data's distribution, what do we do? In this case we can use extreme value theory (EVT). This statistical approach is concerned with the question 'what is the distribution of the data's maximum?' For example, if we compute the largest stock price change ρ_t^{max} each month t for 10 years, does this data have a recognizable distribution? It turns out that the answer is yes.[31] There are three classes of distributions, heavy tailed, bounded, and skinny tailed. Statistical researchers on EVT such as De Haan and Ferreira (2006) focus on the behaviour of the maximum. Specifically they consider the variable

$$M_n = \max\{X_1, ..., X_n\},$$

where $X_1,...,X_n$ is a sequence of independent random variables, with common distribution function F. Since the variables are independent, the distribution of the maximum is exactly derivable:

[31] EVT is not concerned with the law of large numbers as applied to averages: instead, EVT focuses on 'laws of small numbers' applied to maxima and minima. EVT can also be seen as a potential solution to the critiques of Taleb (2004) discussed initially.

$$\begin{aligned}\Pr\{M_n \leq z\} &= \Pr\{X_1 \leq z, X_2 \leq z\}, \ldots, X_n \leq z\} \\ &= \Pr\{X_1 \leq z\} * \Pr\{X_2 \leq z\} * \ldots * \Pr\{X_n \leq z\} \\ &= \{F(z)\}^n.\end{aligned}$$

The main issue is that F is generally unknown, so EVT looks for approximate families of models for F. In order to simplify, it is typical to work with a normalization, to stabilize the location and scale of M as n increases. Thus, EVT works with the variable

$$M_n^* = \frac{(M_n - a_n)}{b_n}$$

Formally, one is interested in the conditions under which there exist normalizing constants *an* > 0, *bn* such that the distribution of the standardized block maxima (Mn) weakly follows a specific type of extreme value distribution function G. In fact, EVT shows that if $\Pr\{M^*_n \leq z\}$ converges to some non-degenerate distribution function G(z), then G belongs to one of three statistical families, corresponding to heavy tails, bounded tails, and skinny tails.[32] It turns out that most financial data has heavy tails, which corresponds to the following distribution:

$$G(z) = \exp(-z^{-\alpha}), \qquad \text{(a)}$$

Where z > 0, and α > 0. The parameter α measures the strength of the tail behaviour. To summarize EVT, this approach specifies what is the distribution of the maximum values. How does this help us? What it means is that, when faced with real world data on securities, we can gather data on the maxima, M, which could include international stock indices or exchange rates. Then we can estimate the tail index α from Equation (a), in order to assess the likelihood of extreme events. This method has been used in international finance, for example, by Longin and Solnik (2001), and by Hartmann, Straetmanns and de Vries (2004)

[32] EVT does not say much about what happens if there is no converges. For more details on EVT, see Berliant et al (2005) and de Haan and Ferreira (2006)

3.1 METHODOLOGY

However, for this thesis we would focus on the binary response approach which is the logit estimation. Binary variables take a value of 1 or 0 depending on which of two possibilities occurs. A very simple example could be that a variable y that measures whether the Turkish exchange rate e_T moves up or down:

$$y = \begin{cases} 1, & \text{if } e_T \text{ goes up} \\ 0, & \text{if } e_T \text{ goes down} \end{cases}$$

Now, if we wish to estimate the effect of political risk p and inflation I on the Turkish exchange rate, we could consider the following regression[33]:

$$y = \beta_p \cdot P + \beta_I \cdot I + \varepsilon \qquad \text{(b)}$$

The fact that $\boldsymbol{y}$ is a binary number makes it difficult to interpret the estimated coefficients. For example, if $\beta_p = -2$ does this mean that an increase in political risk by 1 unit affects the probability of higher exchange rates by -200%? Of course, probability must be contained to be between 0 and 1, so that $Pr(y=1) \in (0,1)$. Specifically, we need a function F that satisfies:

$$\Pr(y = 1) = F(\mathbf{X}\beta),$$

where $X = [PI]$ and $\beta = [\beta_p \; \beta_I]$. This function F must map the coefficients into the interval (0,1). One candidate for F is the logistic distribution, represented by Λ[34]:

$$\Pr(y = 1) = \Lambda(\mathbf{X}\beta) = \frac{\exp \mathbf{X}\beta}{1 + \exp(\mathbf{X}\beta)} \qquad \text{(c)}$$

The most important items from estimating a logistic model are the *sign* and significance of the β estimates. The actual value is more difficult to interpret than in OLS[35].

[33] Political risk could be measured by an index of the number of major negative political news during the sample period.

[34] There are many other candidates for *F* besides the logistic. A popular alternative is the probit model which uses the normal distribution, and therefore has less weight in the tails.

[35] More details on logistic estimation can be found in chapter 13 of Johnston and DiNardo (1997)

In order to assess the main hypothetical causes of subprime crises, we estimate a regression model based on the proposed causes of the crises. This takes the shape of a logit model which, given the factors discussed below, estimates the probability that a crisis occurs. This probability is assumed to follow the logistic cumulative distribution function, that is,

$$P_i = E(Y = 1|X_i) = \frac{1}{1 + e^{-\beta X_i}}, \qquad (1)$$

where P is the probability of crisis a particular year, X is the transposed vector of all independent variables, β a vector of coefficients, and Y takes on the value one if a crisis occurs. Dividing this by (1-P) gives the odds ratio, which, by taking logarithms, is simply expressed as,

$$L_i = E(Y = 1 \mid X_i) = \ln\left(\frac{1}{\left(1 + e^{-\beta X_i}\right)\left(1 - \frac{1}{1 + e^{-\beta X_i}}\right)}\right) = \ln\left(e^{\beta X_i}\right) = \beta X_i \qquad (2)$$

where L is the logarithm of the odds ratio. In other words, the function has been liberalized which allows different types of standard operations. Using quarterly observations for the period between 1998 to 2007 with Y=1 indicating a crisis quarter and Y=0 a non-crisis quarter, it is now possible to estimate the parameters of this function.

Given the discrete binary dummy as an endogenous or dependent variable, the estimation of the ordinary least square (OLS) and the two-state least square (2SLS) are not appropriate. Since the logit model is a nonlinear model, precisely non-linear in parameters, the model faces misspecification and heteroscedasticity problems. The consequences of misspecification in models estimated by maximum likelihood appear to be straightforward. If we maximise the correct likelihood function, we get consistent estimates. An estimate obtained from maximizing an incorrect likelihood function is often referred to as quasi-maximum likelihood (QML) estimate. According to Johnston and Dinardo (1997) the MLE is consistent even in the face of heteroscedasticity, non-normal errors, and serial correlation as long as *plim* (1/N) X'ε = 0. Heteroscedasticity does not generate an inconsistent $\widehat{B}$,[36] but the

[36] $\hat{B}$ is the estimato, that is the solution to the maximization of the likelihood converges to some parameter B^*. In particular, $\hat{B}$ is distributed asymptotically normally with the covariance matrix Ω.

standard errors will have to be modified to account for the misspecification and this has been done as indicated in equation (2). However, in a logit model, any misspecification of the likelihood function will result in inconsistency.

3.2 EMPRICAL SPECIFICATION

Observation has made me focus on just two factors which we think intuitively must have caused the crisis: interest rate and housing prices. The housing price index is expressed as a rate of change. These indicators and their theoretical motivation are thus as follows:

Interest Rate: Interest rates have been relatively low for the first part of the decade. This low interest rate environment was supposed to help the economy recover from the internet bubble. One of the reasons mentioned by economists for the crisis was the very low level of mortgage interest rates. However, we would discover that this in turn was caused by historically low level of short-term interest rates cut by the Federal Reserve due to economical recession in 2001-2002 after dotcom crash (The Economist - Jun 16th 2005).

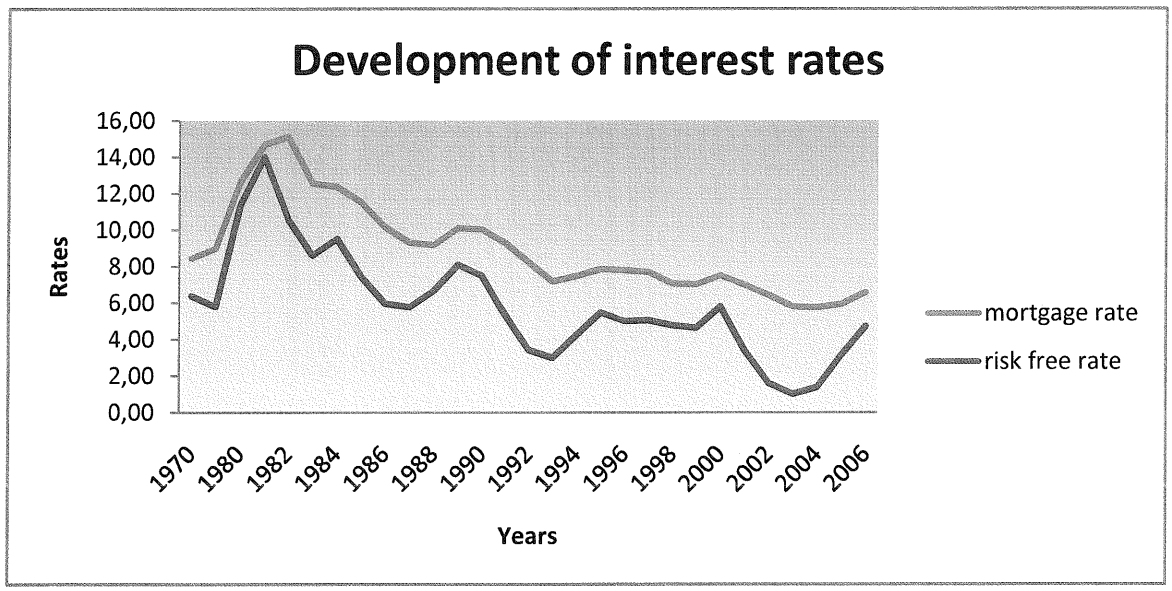

Figure 0-1: Development of interest rates in United States

Source: US Federal Reserve

Americans are known for their strong desire for owning property. This probably comes from the popular saying that "it is always better to buy a house rather than rent" (The economist - Mar 3rd 2005). Further, many had "lost faith in equities after stock markets plunged"[37] and therefore owning property seemed to be more attractive and safer investments (The

[37] "The Economist" - In come the waves, June 16th, 2005

economist, homes as cash machines – June 16th 2005). The shown low mortgage rates in **Figure 0-1** encouraged them to borrow money and buy houses and hence, the housing sales increased as depicted in **Figure 0-2** below.

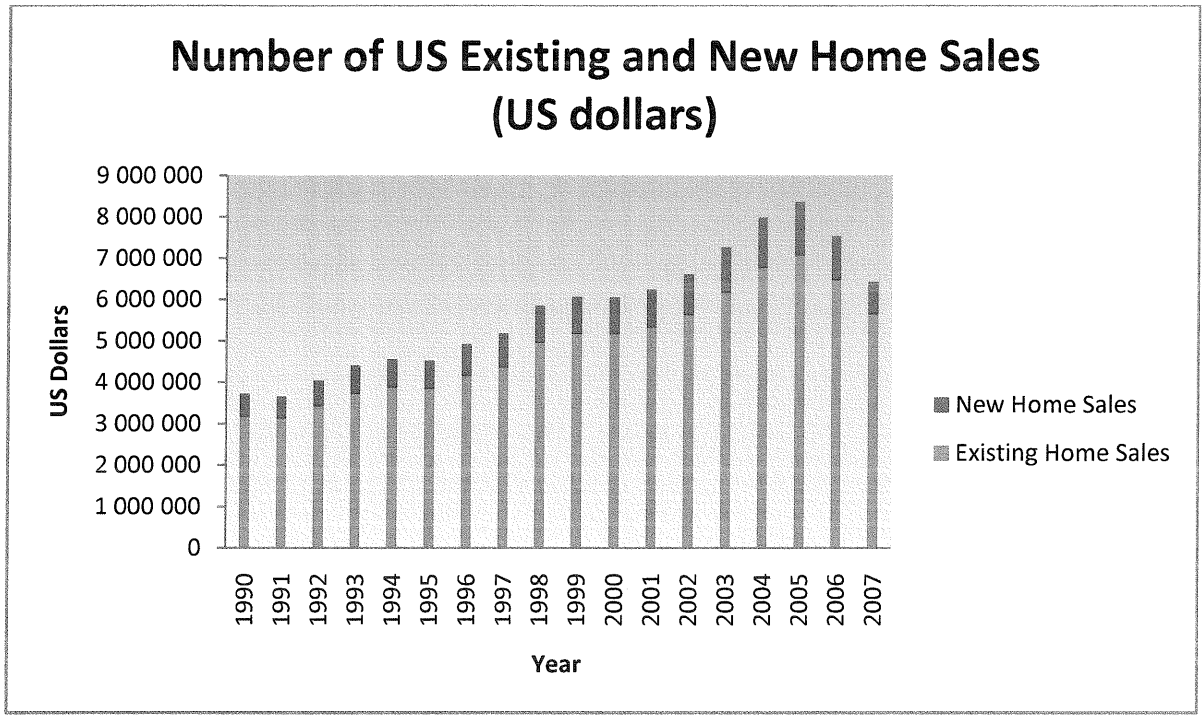

Figure 0-2: Number of US Existing and New Home Sales (US dollars)

Some economists like Dean Baker (2005)[38] argued that "the Federal Reserve has tacitly encouraged risky speculation through its role as a chief regulator of the banking industry, which has steadily relaxed lending standards and allowed home buyers to borrow more money through higher-risk loans". Some loans like interest-only or negative-amortization loans are highly used. The Economist quoted the example of California where 60% of new mortgages in 2005 were in this category (whereas the national level was 1/3). One of the most risky one is certainly the "adjustable-rate mortgages" (ARMs) which differs from a fixed-rate mortgage in many ways. Indeed "the interest rate changes periodically, usually in relation to an index, and payments may go up or down accordingly" (www.federalreserve.gov). The fed itself recognizes the complexity of such loans because in order to "*compare two ARMs with each other or to compare an ARM with a fixed-rate mortgage, you need to know about indexes, margins, discounts, caps on rates and payments, negative amortization, payment options, and recasting (recalculating) your loan. You need to consider the maximum amount your monthly payment could increase. Most important, you*

[38] The New York Times, Fed Debates Pricking the U.S. Housing 'Bubble' - May 31, 2005

need to know what might happen to your monthly mortgage payment in relation to your future ability to afford higher payments". In a word, a buyer needs to be well informed or to be an expert to evaluate properly his ability to afford a mortgage loan.

The low interest rate has spurred increases in mortgage financing and substantial increases in house Prices. Therefore, an increase in the interest rate would increase the mortgage rates and people would not be able to meet their obligations especially if their income is not increasing at the same pace. This we believe will increase the delinquency rate thereby spurring the crises. We expected it to have a positive sign.

***Housing price Index**:* An increasing housing price index would be seen generally as a good sign as the lenders know that if the borrowers are unable to pay their mortgages, they can easily repossess the house and sell it in the market. Taking a cursory look at the US S&P/CASE SHILLER national home price index, and analysing the yearly change, as seen shown below in Figure 0-3

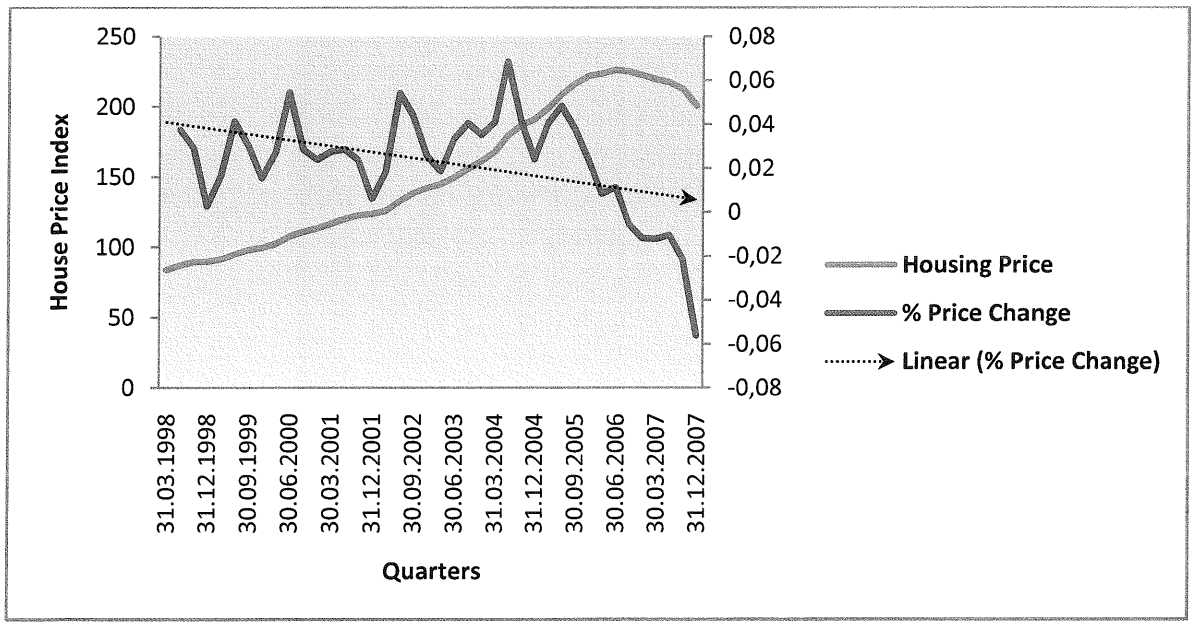

Figure 0-3: US S&P Case-Shiller Housing prices trend

It can be seen that the index has been increasing on annual basis until 2007. However, when looking at the rate of increase, there should have been warning signals in 2006, when the annual rate decreased by more than 50% from 13% to 5%. Although this does not necessarily indicate that it will continue, it should alert decision makers that a problem can arise. However, this could be a situation where the individuals have a tendency to follow the status

quo, rather than take actions to correct it. The US S&P/Case Shiller national home price index has increased from 75 in 2002 to 189 which represents an increase of 152% in 14 years.

The fast growing prices were an incentive for "amateurs making infrequent transaction" to invest in real estate, even if this expectation of future increase in prices may be seen as unrealistic. Therefore, homebuyers think that a home that they would normally consider too expensive for them is now an acceptable purchase because they will be compensated by significant further price increases. In addition, this choice was often based on the basis of limited information and with little or no experience in gauging the fundamental value of the houses they were buying and selling (MH. Smith and G. Smith – 2006). The speculative fever was further heated up by aggressive promotion of real estate in media which resulted in the house prices increasing even more. Shiller and Case (2003) argue that "a tendency to view housing as an investment is a defining characteristic of a 'housing bubble". The National Association of Realtors (NAR) found that "23% of all American houses bought in 2004 were for investment, not owner-occupation". (The Economist - Jun 16th 2005). All this caused a beneficial boom to the real estate market which also had a positive effect on the rest of the economy: a lot of new jobs in construction and real estate industry were created (The economist, the fed frets – June 16th 2005) and consumer spending increased greatly.

The continuous increase in housing prices can be seen to reduce the probability of a crisis given that as long as housing prices increase, the lenders would not worry much about the rate of delinquency. Higher housing equity leads to better opportunities to refinance the mortgage loan. Thus I expect this variable to have a negative sign, that is, reduce the probability of a crisis occurring if housing prices continues to increase.

It is worthy of note that although housing prices were increasing, the median US household income, however, did not proportionately increase, which clearly does not reflect a healthy growth as shown in Figure 0-4 below. On the contrary, it can be interpreted as a bubble indicator.

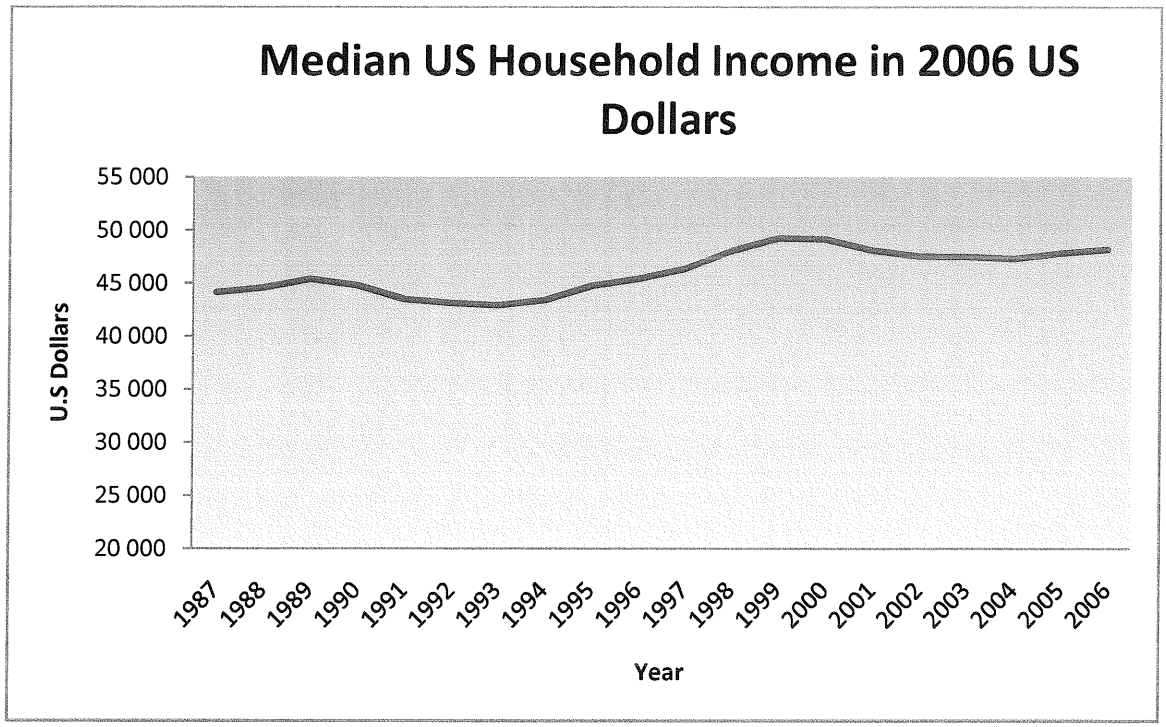

Figure 0-4: Median US Household Income. Source: U.S. Census Bureau

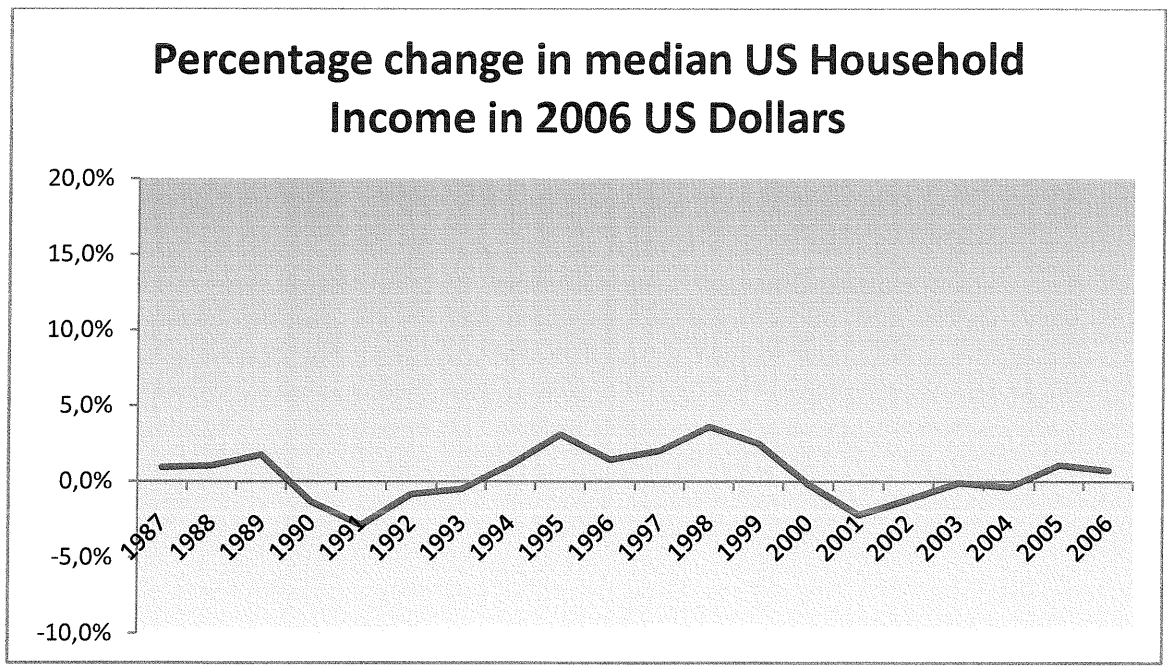

Figure 0-5: Percentage Change in Median US Household Income. Source: U.S. Census Bureau

The indicators were lagged four periods in the regression. Thus the function to be estimated is:

$$\hat{L}_t = \frac{P_t}{1-P_t} = \alpha_1 + \beta_1 \Delta HP_{1,t-4} + \beta_2 \Delta i_{2,t-4} + \varepsilon_t \qquad (3)$$

Where $\Delta HP_{1,t-4}$, $\Delta i_{2,t-4}$ denotes change in housing prices lagged four quarters and change in interest rate lagged four quarters. I have lagged them to indicate that the effects and impacts of each of the variable would not be felt until perhaps after a year.

The table below summarizes our expected signs in case of a forthcoming crisis.

Indicator	Expected Sign
Change in Home Prices	Negative
Change in interest rate	Positive

The percentage increase in price should be negative, that is with increases in the housing prices, this is less likely to cause a crisis and the coefficient of the interest rate we expect it to positive since as interest rate rises, it increases the probability of a crisis since this will trigger an increase in mortgage rate especially for ARM mortgages[39] and thus we can expect more people to default on their mortgages.

3.3 Data & Sources

Our approach to the discrete-choice method of predicting subprime crisis, and therefore the underlying causes, is based on the simplest intuition and not a lot of work has gone into determining the predictability of the subprime credit crisis using our binary choice model and most work regarding this credit crisis has been mainly descriptive in nature or seems clear in hindsight. First of all, it is very parsimonious: We included only two explanatory variables. Secondly, the model is based on simplest possible intuition. Different underlying intuitions that one could include as the cause of the subprime crises are far more complex. This involves including variables such as FICO scores[40], Combined Loan-to-Value ratio, Origination amount[41] and Documentation dummies[42]. One can be a bit sceptical about these

[39] An adjustable rate mortgage, called an ARM for short, is a mortgage with an interest rate that is linked to an economic index. The interest rate, and your payments, are periodically adjusted up or down as the index changes.

[40] FICO score is a credit score developed by Fair Isaac & Co. It attempts to condense a borrower's credit history into a single number.

[41] Origination amount is the amount involved or received by the lenders in subprime mortgages. The higher these fees are, the more they would want to get more subprime mortgages without actually particular whether the borrower would be able to service the mortgage or not. There is a moral hazard problem here.

approaches, since the inclusion of so many variables entails a great risk of multicollinearity. Also, variables with weak intuitive justifications might be also included. Thus if the estimated parsimonious model is inadequate to predict the crisis, the use of more complex models to this extent is then justified.

Thirdly is the difficult question of defining a crisis[43]. This generally involves a lot of arbitrariness. Defining what a crisis is, can be a daunting experience, and generally includes a lot of arbitrariness. I have defined a crisis as when there is a great volatility in the delinquency rate which happened to have started within the third quarter of 2007. In order to determine when the crisis started, I estimate the "unnormal" increase of the number of Delinquencies and Foreclosures.

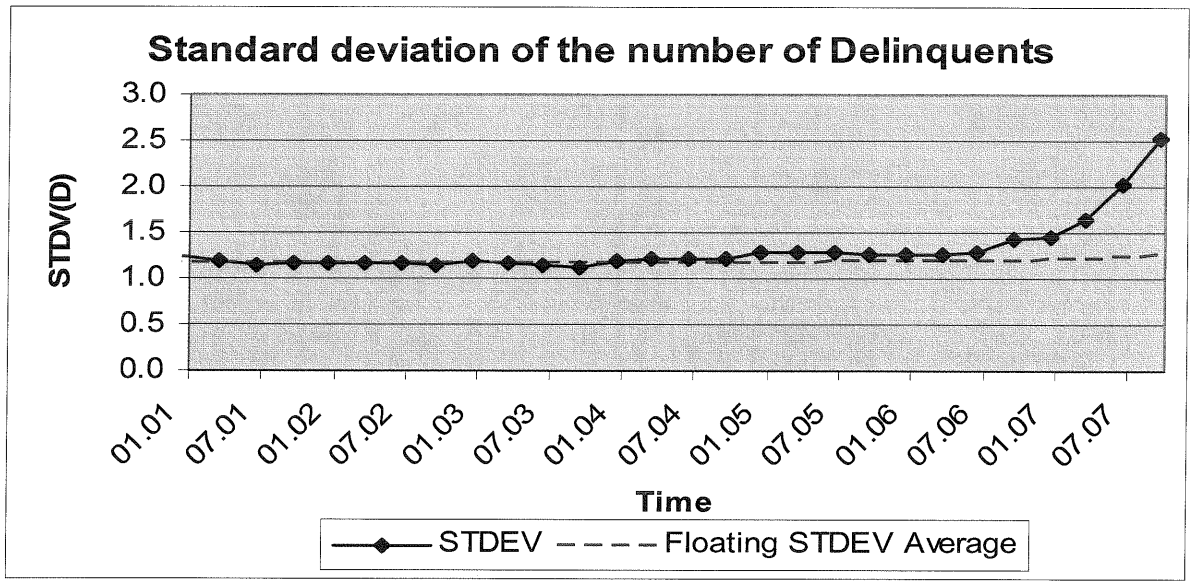

Figure 0-6: Standard deviation of the number of Delinquents

[42] Documentation dummies refer to assigning 0 or 1 when modelling whether there is sufficient and necessary documentation during the origination process. More loans without appropriate documentation increases the probability of a crisis.

[43] Some researchers have defined the *beginning* of a credit crisis by two types of events: (1) bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions (as in Venezuela in 1993); and (2) if there are no runs, the closure, merging, takeover, or large-scale government assistance of an important financial institution (or group of institutions) that marks the start of a string of similar outcomes for other financial institutions (as in Thailand in 1996–1997).

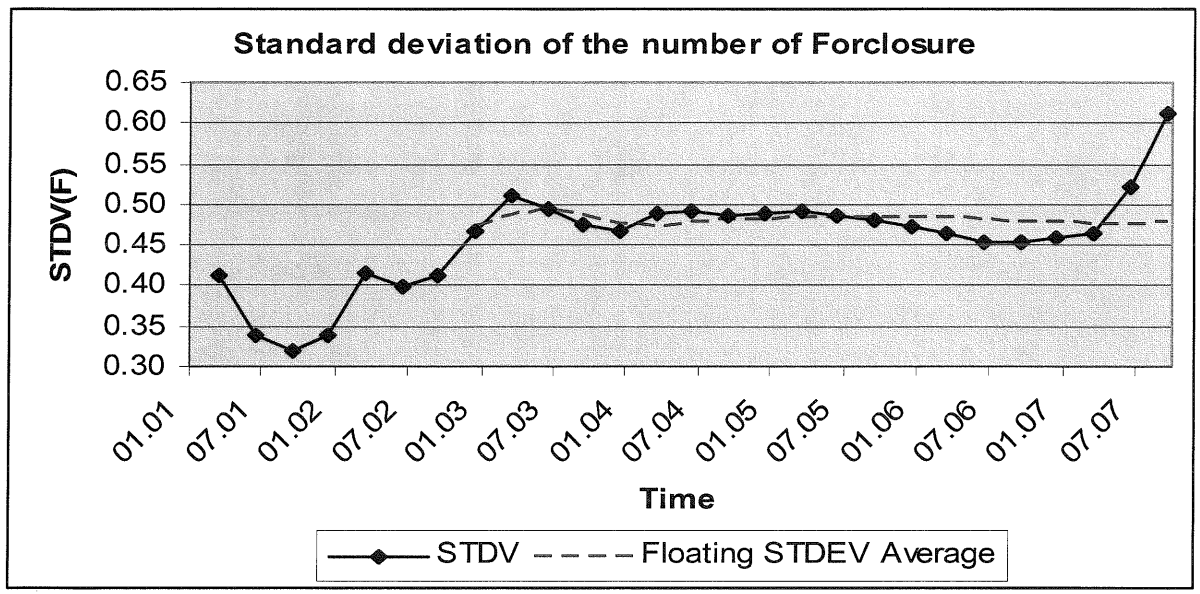

Figure 0-7: Standard deviation of the number of Foreclosure

Both the delinquency and foreclosure rate has a certain amount of volatility that can be regarded as normal. I therefore calculated the floating standard deviation to investigate what kind of volatility is "normal". In theory the floating standard deviation should fluctuate in the beginning but become more stable over time since more numbers are being used. Big changes, however, can also be hidden if we use too many numbers. I therefore focused on data starting from 2001. In addition, I calculated a floating average of this standard deviation to gain the point in time when the crisis started. Both graphs (Fig 0-6 & 0.7) and the development of the foreclosures (Fig 0-7) even better, indicates that the crisis started in the third quarter of 2007.

My approach to dating the crisis is not without drawbacks. It could date the crisis too early, because the worst crisis may come later. However, if we decide to use the definition of crisis as when bank runs that lead to the closure, merging, or takeover by the public sector of one or more financial institutions (as in Venezuela in 1993) or if there are no runs, the closure, merging, takeover, or large-scale government assistance of an important financial institution (or group of institutions) that marks the start of a string of similar outcomes for other financial institutions (as in Thailand in 1996–1997), it also has its own drawbacks. I would be dating the crisis too late, because financial problems usually begin before a bank is finally closed or merged. It can be argued that perhaps the date when the credit crisis hits its *peak,* can be defined as the period with the heaviest government intervention and/or bank closures. However, this can only tell us when the crisis is at its peak but not when it started.

Pertaining to the frequency of observation I have used, several researchers suggest that monthly data better capture the volatile nature of financial crises. Since the housing price index data I got was on quarterly basis, I used quarterly data. However, I could have linearly interpolated the data, I am of the opinion that the benefits of "manipulating" the data in this way do not outweigh the potential drawbacks of it. Like Gujarati (2003) put it "All such data 'massaging' techniques might impose upon the data a systematic pattern that might not exist in the original data."

My data set consists of quarterly data from 1999 to 2007 containing time series percentage change of our chosen indicators. The data was from Federal Reserve Bank reports in wrds for interest rate and the housing price index was from OFHEO -Office of the Federal Housing Enterprise Oversight. I have decided to focus on this small sample period based on two factors

1. I had earlier on pointed out that the subprime credit crisis was as a result of the fed's action in 2000 in order to help boost the economy as a result of the dot-com bubble.

2. Logistic regression can give biased estimate of oversampling or sampling selection bias. This has particularly been demonstrated by King and Zhen (2001). Oversampling refers to a situation where the researchers have collected too many 0's or non-events. For example, what information on international financial crises do we gain by collecting data on Barbados or Canada? Sample selection bias occurs when the researchers collect too many events or 1's. For example, focusing on crisis-prone countries in Latin America. King and Zheng (2001) illustrated this bias using a previous dataset of international conflict determinants. Specifically, they show that even using just 1% of the data set gives very similar estimates. For example in their Table 1, the β coefficients number of years since dispute only moved moved from -0.11 with a full sample to -0.09 with a 1% sample, and the standard errors were the same. Consequently, much of the data could be disregarded in rare event[44] studies. For this reason, since this subprime credit crisis can be considered a rare event, I chose data from 1999 to 2007.

[44] Hertwig et al (2005) define a rare event as an event that has a relatively low probability of happening. In their framework (p.77) a rare event is one with a probability of 0.2, while a more typical event is one with a probability of 0.8. The cut-off of 0.2 is chosen because that is where the divergence between description and learning-based choice is most pronounced.

3.4 Results

Table 1: Summary of Results

Independent Variables	Odds Ratio
Change in Housing Prices (pricechng)	6.75**
Change in Interest rate (intratechng)	2882.55**

** Significant at 5% level of significance

Table 2: Marginal Effects

Independent Variables	dy/dx	Signs
Change in Housing Prices (pricechng)	-8.09**	Negative
Change in Interest rate (intratechng)	0.7735**	Positive
Marginal Effects after Logistics y=0.10897011		

** Significant at 5% level of significance

Given the data and my model specification in equation 3, the results show that the coefficient of both housing prices and interest rates were significant at 5% level of significance. It can be interpreted that for a 1% increase in housing prices, the odds of a crises decreases by a factor 6.75 and a 1% increase in interest rate change increases the odds of a crisis by a factor 2883. The interpretation of this is a bit complex; I therefore make use of predicted probabilities[45]. In other words, with given data and model specification, the results show that it is possible to satisfactorily explain or predict the crisis. Why might this be so? The most obvious explanation is the specification. The indicators involved were simply enough to explain the crisis. Perhaps my specification is the Holy Grail which as Gujarati (2003) put it "searching for the correct model is like searching for the Holy Grail". Therefore I can assert firmly that more complex models, involving far more indicators and a higher level of complexity need not be estimated in order to predict the crisis. I therefore draw the conclusion again that

[45] I used a suit of commands, called **spost** which was written by J.scott Long and Jeremy Freese. The commands can be downloaded prior to their use and this can be done by typing **findit spost9_ado** on the stata data command line. See appendix for full results.

complex models that includes large amount of variables are not needed in order to predict the crisis and the inclusion of various complex indicators might distort the results and the cause of the crisis.

It can be seen that the signs and sizes are consistent with my intuition. The change in housing prices is negative as discussed earlier on which means as housing prices continue to increase, it decreases the probability of a crises. Interest rate also had our expected sign and is positive which means that an increase in interest rate would increase the probability of the crisis which would be felt through an increase in mortgage rate which correlates positively with interest rates.

As can be seen from Appendix in Table 1, the predicted probability of a crisis is 0.7443 for a 1% decrease in housing prices and it reduces to 0.0037 for a 7% increase in housing prices while interest rate is held constant at their mean indicated by the output. In addition the predicted probability of crisis is 0.005 if interest rate increase is by -0.39 and increases to 0.7602 if interest rate increase is by 0.42.

With the interest rate change variable held at its constant mean, the probability of a subprime crisis for a 0.05 change in housing price resulted in a 0.02 probability of a crisis. A decrease of housing prices index change by -0.15 resulted in a probability of 1 which means there is a 100% probability of a crisis. Likewise for the interest rate, a rate of change of 5%, 20%, 75% results in an increased probability of 0.1426, 0.3546 and 0.9777 of a crisis. The implication is that a change of -15%, -25% and -100%, results in a 0.0327, 0.0150 and 0.000 probability of a credit crisis. This perhaps signifies that one of the most potent instruments that the government can use to curb this crisis would be through interest rate reduction.

While none of us know how the events of this crisis would play out eventually as at the time this thesis is being written, I believe the effects would be far greater than any of the previous crisis witnessed. This is because based on this my parsimonious model; interest rates would need to be almost zero in order to put the economy back on track. However, it should be noted that if the government cuts rates to curb the crisis, they will have to battle inflation and also probably the economy would also suffer from exchange rate problems as there would be a need for a lot of government spending to ease the liquidity squeeze which might lead to the

popular twin crisis[46]. This will be open for further research to see how the subprime crisis might lead to a twin crisis in the United States where there will be need to evaluate how the liquidity crisis is or will lead to a balance of payment crisis.

Based on the above, I can therefore say that the subprime crisis was predictable. While I admit that the estimation might be biased. My data perhaps was too small or too large, concentrated around the extreme or perhaps our definition of a crisis seemed to go very well with my model and in deed as Gujarati (2003) said "searching for the correct model is like searching for the Holy Grail". I can therefore conclude that our parsimonious model can be used to predict the probability of the subprime credit crisis and therefore the government could have easily avoided the crisis.

[46] Twin crisis refers to a situation where a country suffers from both financial/banking crisis and currency crisis and it often leads to a severe recession. It was coined by Kaminsky and Reinhart (1999) and generally affects countries through trade and financial linkages.

Chapter 4

4.1 DESCRIPTIVE ANALYSIS

The result of the discrete-choice model highlight a very important lesson: The phenomenon of the credit crisis while it is complex can be deciphered intuitively. In this section, the possibility of prediction is analyzed in a more qualitative way.

In this part, I will investigate if the US sub-prime credit crisis could have been predicted by looking at a number of standard leading financial crisis indicators or macroeconomic variables in predicting crisis, and see whether this crisis has taken a path significantly different from other crisis in the past. For this I will be drawing mainly from the works of Kaminsky and Reinhart (1999) and Reinhart and Rogoff (2008).

The fundamentals chosen to be examined here are: Financial Liberalisation (M2 multiplier, credit to nominal GDP), Lending-deposit rate ratio, Real Housing prices, Real Equity prices, Current Account and growth rate of GDP

4.1.1 Financial Liberalisation

4.1.1.1 M2 Multiplier

Looking back at past financial crises, financial liberalization has been said to precede the banking crises. I therefore look at the M2 multiplier and the ratio of domestic credit to GDP. These indicators have been chosen because of McKinnon and Phill's (1996) "boom-bust cycle" theory that banking crisis that leads to twin crisis are linked to rapid growth in credit and monetary aggregates. According to Kaminsky and Reinhart (1999), the *M2 multiplier*[47] rises at the onset of banking crises and the multiplier grows at above normal rate months prior to the crisis.

Figure 4-1 below shows the evolution of the M2 multiplier and how it played out just before the crisis. The crisis as explained earlier is said to have started in the 3rd quarter of 2007. The M2 multiplier was seen to be rising on the onset of the credit crisis which has been indicated by the blue dot. This is in line with what Kaminsky and Reinhart (1999) found in their study concerning the banking crises. Much more interesting is the fact that the multiplier grows

[47] The M2 multiplier is the ratio of M2 to base Money and the M2 is the addition of Money and Quasi-Money quarterly series beginning in January 1957 and it is IFS line 11134.ZF and 11135.ZF and the base money (Reserve Money) is IFS quarterly series 11114.ZF.

above normal rate (0.01) in the entire 18 months prior to the crisis and should have served as a warning signal to the policy makers.

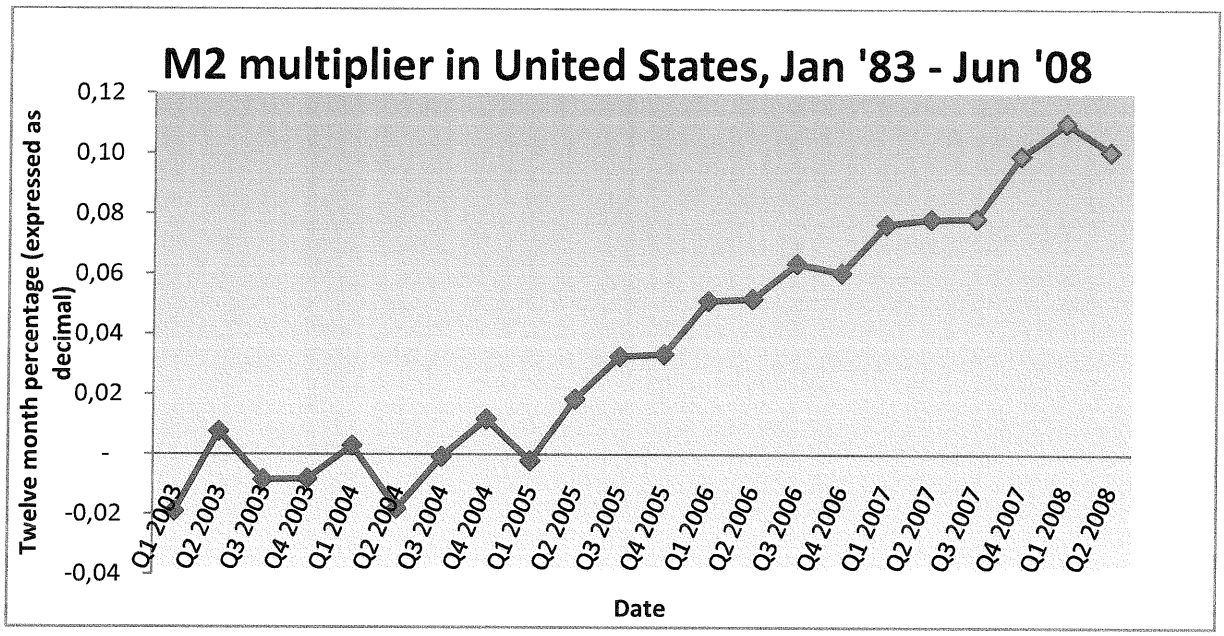

Figure 4-1: M2 Multiplier in U.S.A, Jan 1983 - Mar 2008

The increase in the M2 multiplier which signifies financial liberation should not be surprising. One can argue that no real de jure financial liberalization, however on the contrary there is certainly a de factor liberalization. New unregulated, or lightly regulated, financial entities have come to play a much larger role in the financial system, which has undoubtedly enhanced stability against some shocks, but possibly increasing vulnerabilities against others. Technological progress has plowed ahead, shaving the cost of transacting in financial markets and broadening the menu of instruments.

4.1.1.2 Domestic Credit to GDP

The ratio of *domestic credit to nominal GDP*[48] indicator also tells the same story. The domestic credit to nominal GDP is a twelve month percentage change[49] starting from the 1st quarter in 1958. According to Kaminsky and Reinhart (1999), this indicator rises in the early

[48] The ratio of domestic credit to GDP is then constructed by dividing deflated domestic credit by nominal GDP. Nominal GDP is IFS line 11199B.CZF a quarterly series beginning from 1957. Deflated domestic credit is IFS line 11152.ZF.., a quarterly series beginning from 1957, divided by consumer prices. Consumer price index is IFS line 11164.ZF, a quarterly series beginning from 1957.

[49] The twelve month percentage change works as follows: If one wants to find the percentage for January 1991, then one takes the natural logarithm of the January 1991 value and subtracts the natural logarithm of the January 1990 value. It is then clear why one cannot use the first data point in the time series. In theory, this could result in a change more than -100 percent even for series consisting entirely of positive numbers. This is does not have any effect on the results, since only the relative positions of the values are of interest, i.e., whether the values do or do not exceed a given threshold, defined by *percentile*.

phase of the financial crises and remains above normal as the financial crises near. The evolution of this variable in the years preceding the crisis is given in Figure 4-2 below.

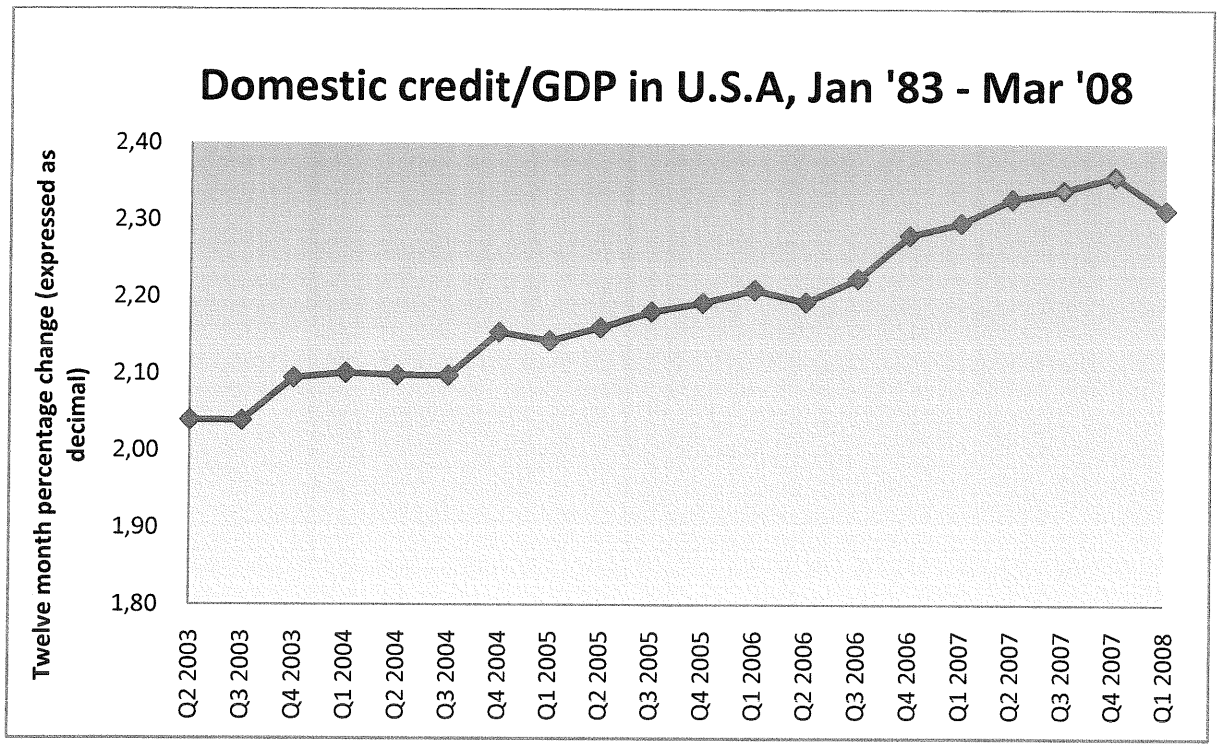

Figure 4-2: Domestic credit/GDP in USA, Jan 1983 - Mar 2008

As can be seen from Figure 4-2, the growth in domestic credit/GDP remains above normal as the financial crises approaches, and throughout this period it remains well above the growth rates on the average of growth rate before the crisis period which was 1.33, and is also consistent with a credit boom story. The ratio also rises in the early phase of the financial crisis. It may be that, as the crisis unfolds, the Treasury was pumping money to the banks to alleviate their financial situation or the evolution of the denominator (GDP) has changed. While credit is rapidly expanding 6 quarters to 2 quarters before the crisis, the economy is still in a vigorous expansion phase with healthy GDP growth. The leveraging of households and business becomes evident as the economy slips into recession. This indicator also represents the wealth effect.

4.1.2 Lending-Deposit rate ratio

I have earlier mentioned that Mortgage brokers wrote loans of increasingly poor quality, including many that were apparently fraudulently obtained. In another conflict of interest, appraisers, whose livelihoods depended on getting work from front-line lenders and brokers,

colluded in fraud by making higher-than-justified assessments of home prices. In order to see whether loan quality deteriorated or increased, we used the *lending-deposit rate ratio*[50].

The evolution of this variable in the years preceding the crisis is given in Figure 4-3 below

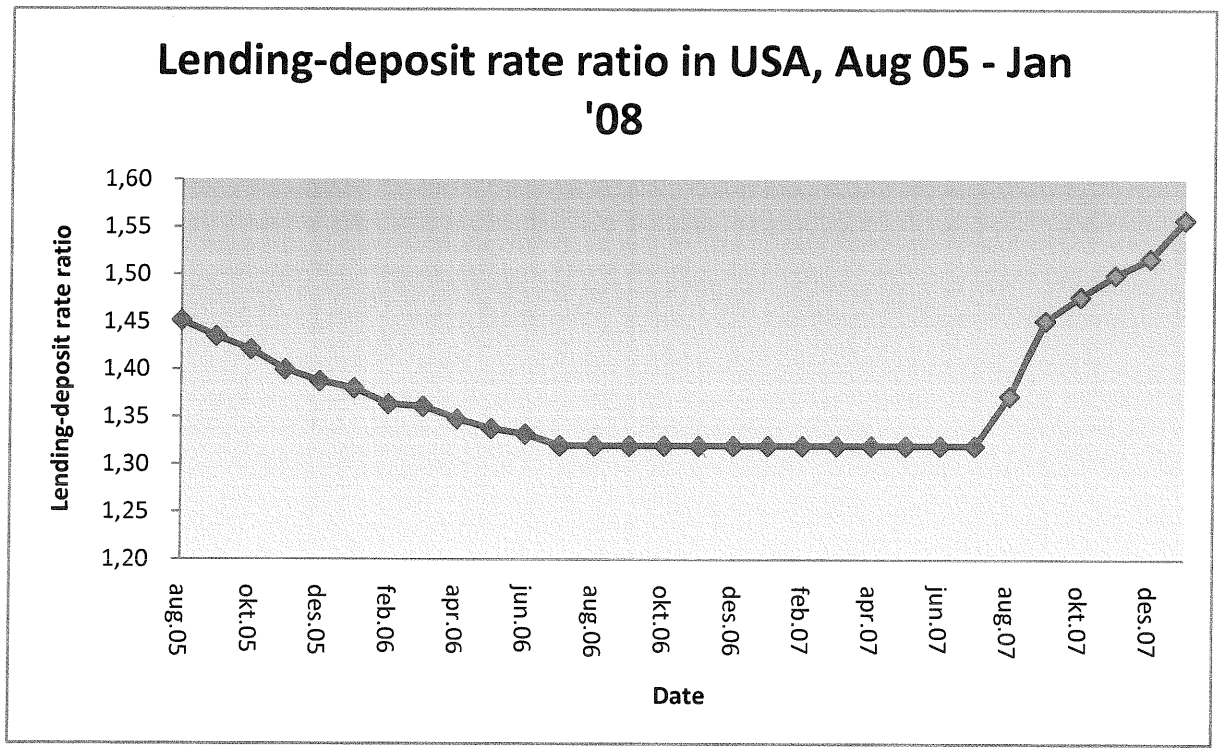

Figure 4-3: Lending -deposit rate ratio in USA, August 2005 - January 2008

The lending-deposit rate ratio remains close to normal levels before the crisis started but begin to increase above the normal level as the crisis started in September 2007, as banks become increasingly unwilling to lend. An increase in the lending/deposit ratio captures a decline in loan quality and possibly reflecting deterioration in credit risk.

4.2 MACROECONOMIC FUNDAMENTALS

I also sought to compare the United States credit crisis characteristics the years preceding the crisis with those of the other five big five crises: Spain (1977), Norway (1987), Finland (1991), Sweden (1991) and Japan (1992), where the starting year of the crises is in parenthesis. A short summary of the big five crises are:

[50] The lending deposit rate ratio is obtained by dividing the ordinary lending rate by the discount rate. i.e IFS line 60p divided by IFS line 60 which was used in lieu of differential to ameliorate the distortions caused by the large percentage point spreads observed during high inflation. This series begins in January 1957 and is in monthly series to adequately capture the volatility since the data was also available in monthly data.

- Spain (1977) where 51 institutions holding 1/5 of all deposits were rescued and in 1983 the government nationalized 20 small /medium sized bank and estimated losses of the bank was approximately 16.8% of GNP

- Norway (1987) where the Central bank provided special loans to six banks suffering from post-oil recession of 1985-86 and from problem real estate loans; state took control of 3 largest banks, partly through a Government Bank Insurance Fund had to increase capital to Nkr 11 billion. Estimated recap losses amounted to 4% of GDP.

- Finland (1991) where the Savings banking sector badly affected; Government took over control of Skopbank in August 1991 and several banks also suffered losses due to bad loans and share investments. Recap costs amounted 8% of GDP.

- Sweden (1991) where Government injected Skr 5 billion (US$800 million) into state controlled Nordbanken and guaranteed US$609 million bank to save largest savings banks with cost of recap. Amounting to 6.4% of GDP.

- Japan (1992) where Banks suffered from sharp decline in stock market and real estate prices; official estimate of NPLs: 40 trillion Yen (US$469 billion) in 1995 (10% of GDP); unofficial estimates reach 1 trillion or 25% of GDP; for some bad loans banks have already made provisions. Rescue costs were pegged at higher than US$100 billion.[51]

Justice has already been done to this aspect of comparing the Macro-economic fundamentals of the US finance crisis with the other big five crises and other banking and financial crises which include Australia (1989), Canada (1983), Denmark (1987), France (1994), Germany (1977), Greece (1991), Iceland (1985), and Italy (1990), and New Zealand (1987), United Kingdom (1974, 1991, 1995), and United States (1984) by Reinhart and Rogoff (2008)[52] and most of the conclusions arrived here are mainly culled from their article.

Their examination of the longer historical record, which is part of a larger effort on currency and debt crises, finds stunning qualitative and quantitative parallels across a number of standard financial crisis indicators. To name a few, the run-up in U.S. equity and housing

[51] Caprio and Klingebiel (1996)

[52] Reinhart, Carmen M. and Rogoff, Kenneth S. (2008): *Is the 2007 U.S. Sub-Prime Financial Crisis So Different? An International Historical Comparison*, NBER Working Paper No. W13761

prices that Graciela L. Kaminsky and Carmen M. Reinhart (1999) find to be the best leading indicators of crisis in countries experiencing large capital inflows closely tracks the average of the previous eighteen post World War II banking crises in industrial countries. So, too, does the inverted v-shape of real growth in the years prior to the crisis. Despite widespread concern about the effects on national debt of the early 2000s tax cuts, the run-up in U.S. public debt is actually somewhat below the average of other crisis episodes and in contrast, the pattern of United States current account deficits is markedly worse.

The precedents found in the aftermath of the other episodes suggests that the strains can be quite severe, depending especially on the initial degree of trauma to the financial system (and to some extent, the policy response). As earlier indicated, while this thesis is still open to how the US financial crisis will play out, I am of the belief that it will by far dwarf the precedents found in other episodes. The average drop in (real per capita) output growth is over 2 percent, and it typically takes two years to return to trend. For the five most catastrophic cases (which include episodes in Finland, Japan, Norway, Spain and Sweden), the drop in annual output growth from peak to trough is over 5 percent, and growth remained well below pre-crisis trend even after three years. These more catastrophic cases, of course, mark the boundary that Policymakers particularly want to avoid.

Their comparison employed a small piece of a much larger and longer historical data set they had constructed (see Reinhart and Kenneth S. Rogoff, 2008.). The extended data set catalogues banking and financial crises around the entire world dating back to 1800 (in some cases earlier) and in order to focus on data most relevant to the present U.S. situation, they do not consider the plethora of emerging market crises, nor industrialized country financial crises from the Great Depression or the 1800s. Nevertheless, even in the smaller sample considered in their paper, the refrain that "this time is different" syndrome has been repeated many times.

First come rationalizations. This time, many analysts argued that the huge run-up in U.S. housing prices was not at all a bubble, but rather justified by financial innovation (including to sub-prime mortgages), as well as by the steady inflow of capital from Asia and petroleum exporters. The huge run-up in equity prices was similarly argued to be sustainable thanks to a surge in U.S. productivity growth a fall in risk that accompanied the "Great Moderation" in macroeconomic volatility. As for the extraordinary string of outsized U.S. current account deficits, which at their peak accounted for more than two-thirds of all the world's current

account surpluses, according to them, many analysts argued that these, too, could be justified by new elements of the global economy. Thanks to a combination of a flexible economy and the innovation of the tech boom, the United States could be expected to enjoy superior productivity growth for decades, while superior American know-how meant higher returns on physical and financial investment than foreigners could expect in the United States.

Thereafter, reality sets in, where starting in the summer of 2007, the United States experienced a striking contraction in wealth, increase in risk spreads, and deterioration in credit market functioning. The 2007 United States subprime crisis has it roots in falling U.S. housing prices, which have in turn led to higher default levels particularly among less credit-worthy borrowers. The impact of these defaults on the financial sector has been greatly magnified due to the complex bundling of obligations that was thought to spread risk efficiently. Unfortunately, that innovation also made the resulting instruments extremely non-transparent and illiquid in the face of falling house prices.

4.2.1 Real Housing prices

A variety of simple comparisons between the 2007 U.S crisis and previous episodes. Also drawing on the standard literature on financial crises, they looked at asset prices, real economic growth and public debt. Figure 4-4 compares the run-up in housing prices. Period *T* represents the year of the onset of the financial crisis. By that convention, period *T-4* is four years prior to the crises, and the graph in each case continues to *T+3,* except of course in the case of the U.S 2007 crises, which we are yet to see how it plays out. The chart confirms the case study literature, showing the significant run-up in housing prices prior to a financial crisis. It can be seen that the housing prices in the United States exceeds that of the "big five".

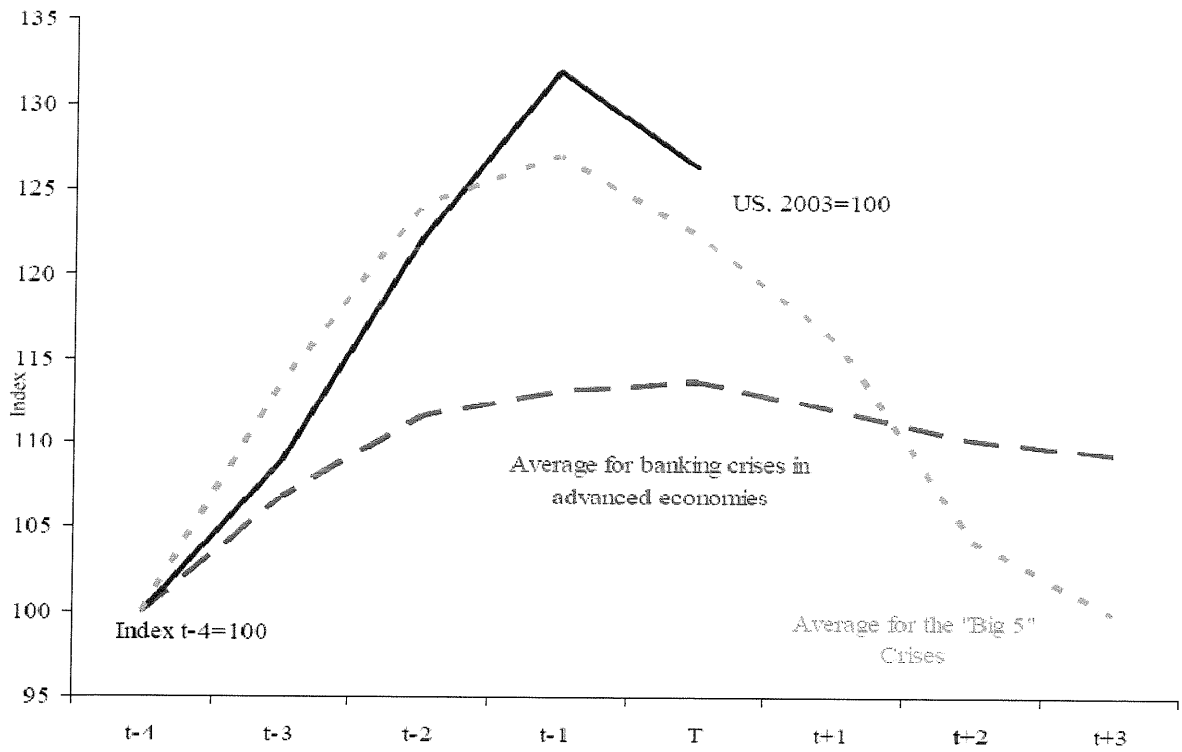

Figure 4-4: Real Housing prices and Financial Crises

Source: Reinhart, Carmen M. and Rogoff, Kenneth S. (2008)

4.2.2 Real Equity prices

Taking a cursory look at the real rates of growth in equity market price indices, we again see that the United States looks like the archetypical crisis country, only more so. It can be seen from Figure 4-5 that the Big five crisis countries tend to experience equity price falls earlier on than the U.S has, perhaps because the U.S Federal reserve pumped in an extraordinary amount of stimulus in the early part of the US credit crisis.

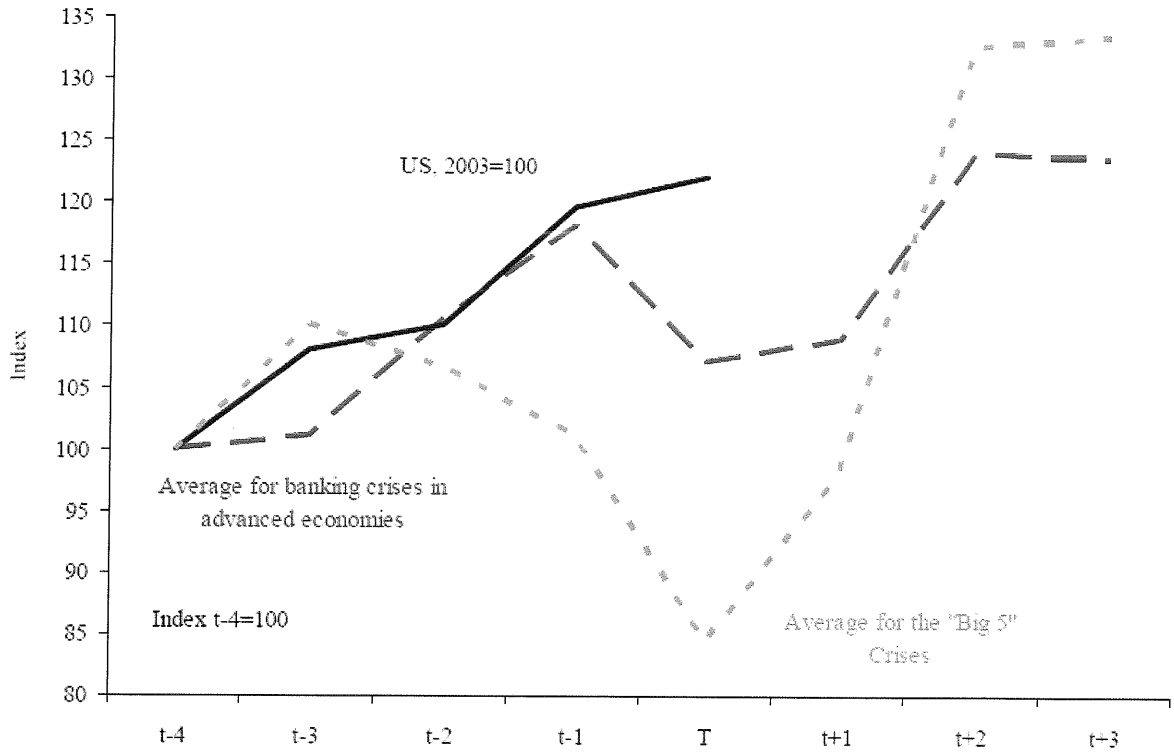

Figure 4-5: Real equity prices and Banking Crises

Source: Reinhart, Carmen M. and Rogoff, Kenneth S. (2008)

As observed before, financial crises are associated with the peaks in business cycles and the financial crisis is a culmination of a period of economic expansion that leads to a downtown. It can be seen that in the years leading to the crisis, the economy was recording growth rates above the average. Also, the weakening in equity prices is, mostly likely, reflecting both the deteriorating cyclical position of the economy, reduced foreign demand as capital inflows are reversed, and the worsening balance sheets of firms, as the overvaluation takes its toll. It should not be surprising that the beginning of the recession would be reflected in the stock market at *T+1* and possibly in *T+2* in the case of the United States when there is more data. This collapse is already apparent in other asset markets, mostly notably in real estate.[53]

4.2.3 Current Account

Also looking at current account as a share of GDP, the United States is also on a typical trajectory, with inflows accelerating up to the eve of the crisis as seen in Figure 4-6. Indeed,

[53] For example, in the boom period leading up to the 1981 Argentine banking crisis, stock returns (in U.S dollars) were as high as 813 percent during the 12 months ending May 1979; by May 1981, the 12 month capital loss was 60 percent. The crash in asset values is cited in most Case studies as an important factor contributing to the problem of the banks.

the U.S deficits are more severe, reaching over six percent of GDP. That the U.S can be able to run such a large deposit is no news again, as there is a large and growing literature that attempts to rationalise why the United States might be able to run a large sustained current account deficit without the great risk of trauma. Whether the U.S case is quite different as the literatures suggest is yet to be seen.

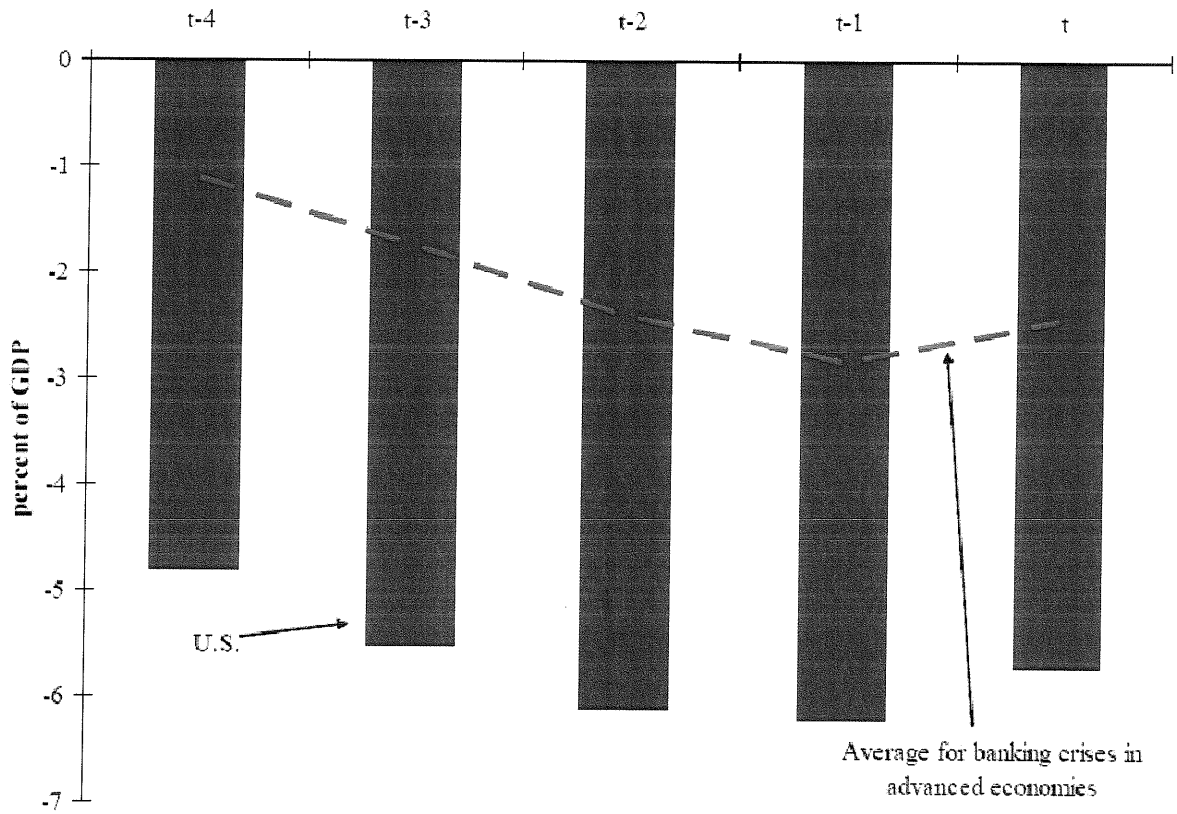

Figure 4-6: Current Account Balance/ GDP on the eve of banking crises

Source: Reinhart, Carmen M. and Rogoff, Kenneth S. (2008)

Looking at Figure 4-6, It can be seen that United States was running a large constant current account deficit during the years running up to the crisis period. A large current account deficit is of course not necessarily a problem as long as the debt is used to finance useful upgrades of productivity and competitiveness. If GDP increases, it is even possible to maintain a constant debt ratio in spite of increasing capital inflows. But it still implies a vulnerability to sudden reversals if for some reason the lenders decide to withdraw their money. A comparison with three other crisis countries (Mexico (1994), Finland (1992), Sweden (1992), Thailand (1997), as can be seen in Figure 4-7 below, it shows that all of them had growing current account deficits, especially Mexico passing 10% of GDP in 1994.

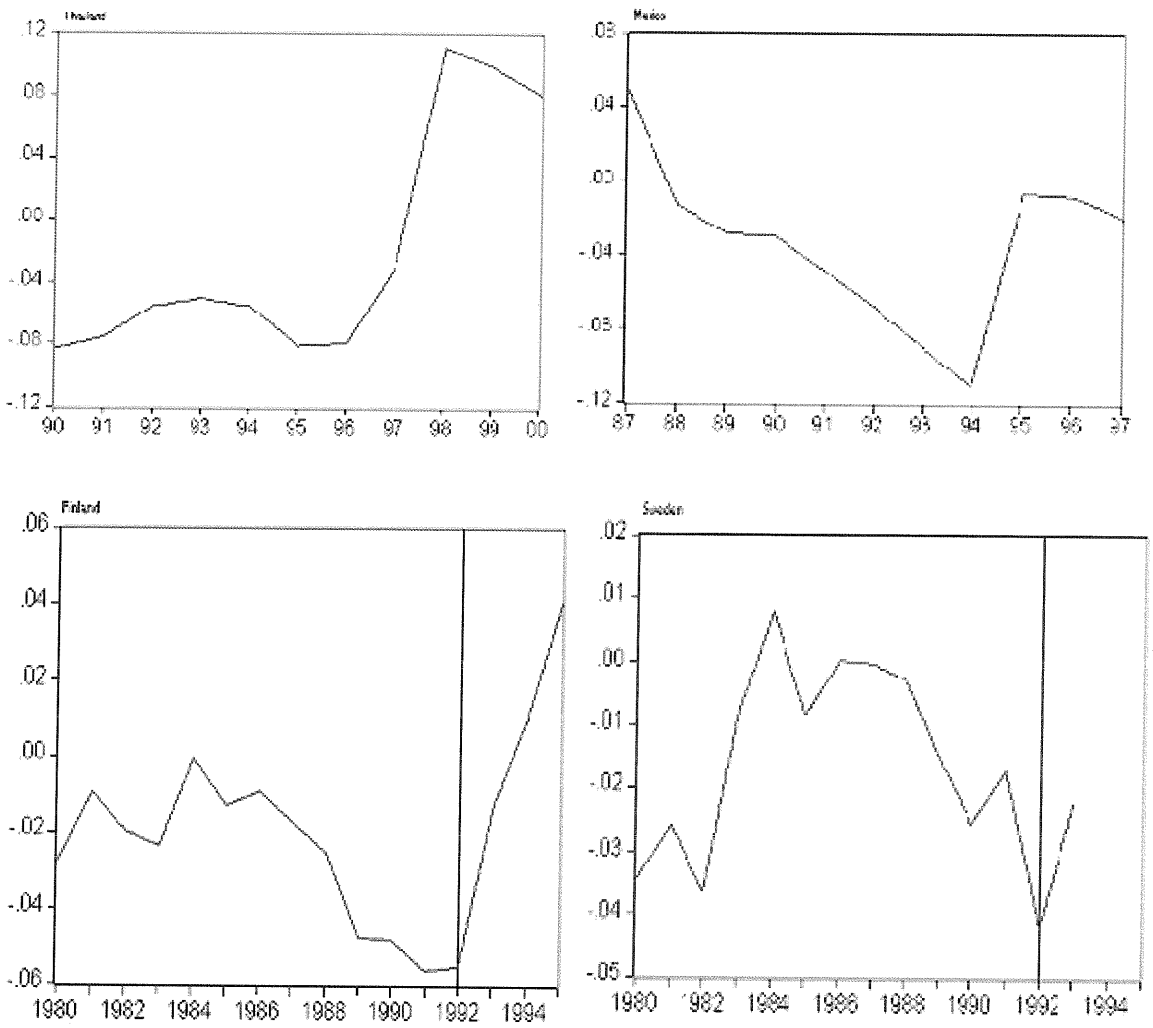

Figure 4-7: CA relative to GDP for Thailand, Mexico, Finland, Sweden. *Source:* ***Söderberg (2005)***

The United States has been running this deficit for years and a large deficit does not necessarily lead to crisis, but over and over again, it seems to be prevalent in a lot of other crisis.

4.2.4 Growth rate of GDP

Both from theory and observation we know that a situation with huge current account deficits can become a problem if the lenders lose confidence in the country's ability to repay its debts in the future or maintain high returns. The indebted country will therefore need to show strong growth and competitiveness statistics to prove that it is indeed worthy of the capital invested in it.

Figure 4-8 shows the evolution of real per capita GDP growth in the run-up to debt crises. The United States still follows the same inverted V shape that characterised the earlier crises. Growth momentum slows and then falls going into the typical crisis, and remains low for about two years after. Looking at the "big five" cases, the growth shock is considerably larger and more prolonged

than for the average episode. Of course this implies that the growth effects are quite a bit less in the mildest cases, although the Unites State's case showed not so many makers of larger problems that one cannot take too much comfort in this caveat.

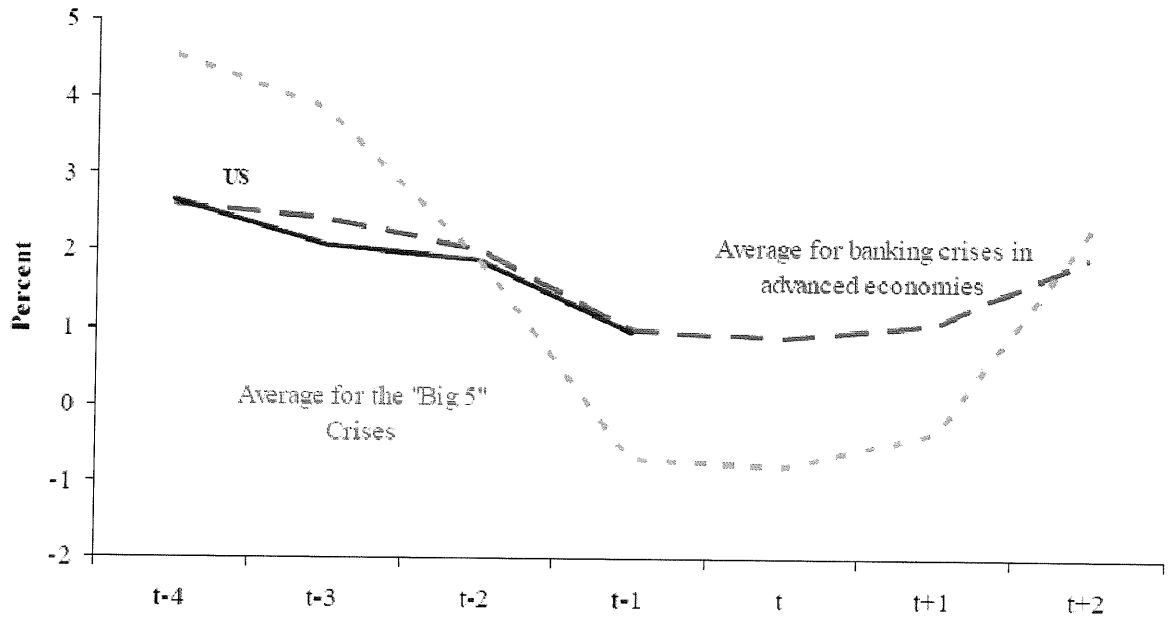

Figure 4-8: Real GDP growth per Capita and Banking Crises (PPP Basis). *Source: Reinhart, Carmen M. and Rogoff, Kenneth S. (2008)*

4.2.5 Public debt

Public debt as a share of GDP as an indicator was also examined, and the U.S. case was also compared with that of the "big five". Rising public debt is a near universal precursor of other post-war crises. Figure 4-9 looks at the public debt as a share of GDP. It is notable that U.S public debt rises much slowly than it did in run-up to the Big five crisis. However, if the huge build up in private U.S debt is incorporated into these measures, the comparisons would be less favourable.

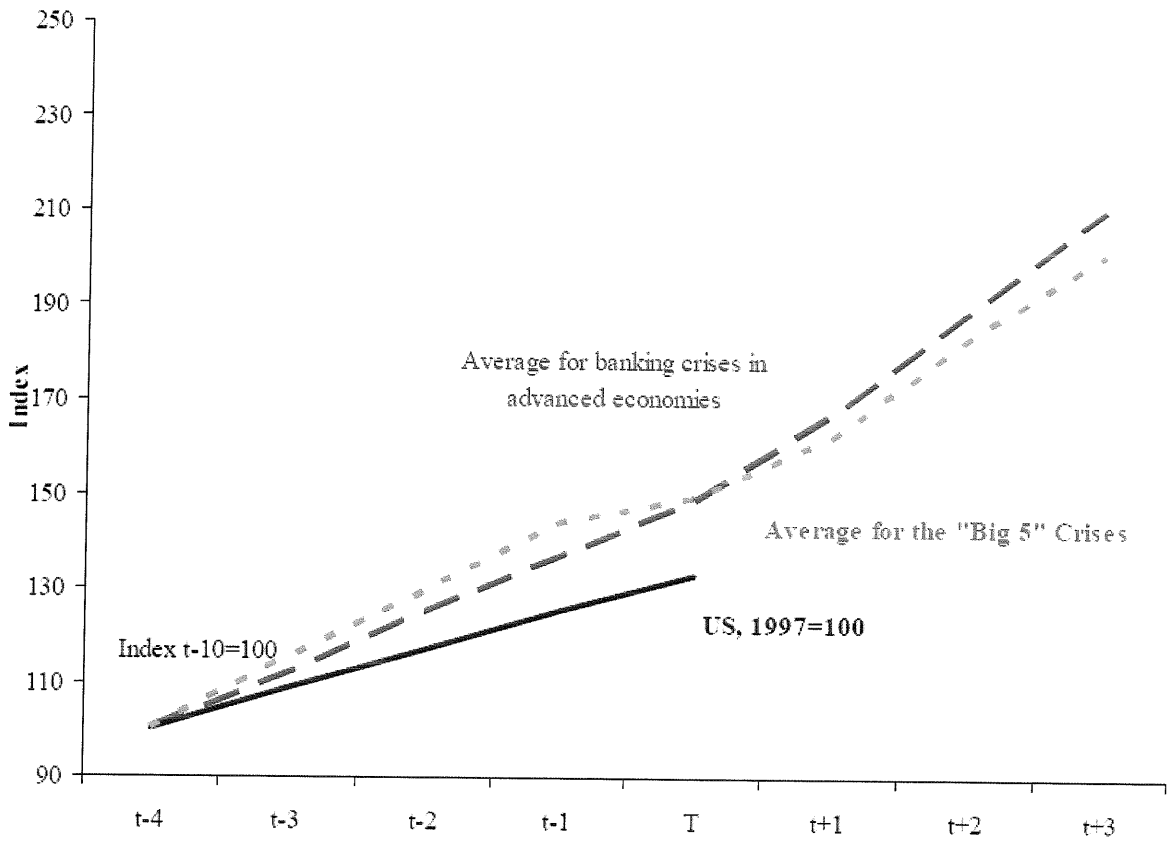

Figure 4-9: Public debt and Banking Crises. *Source: Reinhart, Carmen M. and Rogoff, Kenneth S. (2008)*

There seems to be a correlation in these graphs but these correlations are not necessarily causal, but in combination nevertheless suggest that if the United States does not experience a significant and protracted growth slowdown, it should either be considered very lucky or even more "special" that most optimistic theories have suggested. Indeed, given the severity of most crisis indicators in the run-up to its 2007 financial crisis, the United States can consider itself to be quite fortunate if its downturn ends up being a relatively short and mild one.

Chapter 5

5.1 CONCLUSION AND SUMMARY

This thesis analysed the possibility of predicting the subprime credit crisis in order to determine if it could have been avoided and thus can be labelled a predictable surprise. To this end a number of attempts were tried and/or evaluated.

First, a logit model was estimated, which was able to explain and also predict crises. This indicated that just a few variables are sometimes enough to predict a crisis and that more complex approach is often not justified and needed. I chose intuitively the obvious two reasons as to what would have caused the crisis in the first place. These were *interest rate* and *Housing prices*.

My number one suspect was the very low real interest rates, both short and long term, leading up to the crisis. Real short-term interest rates in the United States were negative from roughly the third quarter of 2002 through the first quarter of 2005. They were barely positive in the Euro zone and Japan during the said period. Mostly that reflected accommodative monetary policies. Real long-term interest rates were also very low, particularly over the period of 2002 to 2007 in both the United States and the Euro zone. That reflected low investment demand and the very high savings rates, particularly in the emerging markets outside China. Low interest rates also reflected what can be termed low-term premium; that is, people were not asking for much premium to purchase longer term securities because they were not that worried about volatility. There was very low volatility in equity and bond markets. What was the upshot of those low interest rates? There were low mortgage rates and of course that stocked the demand for housing. There was also a very pervasive "search for yield," so with very low interest rates on investments, people were looking for more return and they were prepared to take more risk to get it. For example, if you had a complex mortgage-backed security[54] and people even if they do not understand them, were told they would get 70 basis points more than a triple-A rated corporate bond, they were happy to buy them.

My second suspect was the unwarranted confidence about the continued rise and the low volatility of the US housing prices. Looking back from 1996 to 2005, US housing prices nationwide went up about almost 90 percent. In 2000 and 2005 alone, they went up by 60%,

[54] Mortgage-backed security (MBS) are asset-backed security whose cash flows are backed by the principal and interest payments of a set of mortgage loans and payments are typically made monthly over the lifetime of the underlying loans.

and in the 30 year run-up to the crisis, rarely was there a fall in housing prices. So it looked like a terrific investment. It was just the time to buy a new house, to add to your house, to get a home equity loan, and you probably feel that if you did not do it, you were just missing out and you were watching your neighbour get rich. Also, mortgage lenders did not worry as much about making loans to borrowers who did not have such a great credit history, because they felt, "well, even if I make a loan and the borrower puts down very low down payment, in a few years of rising housing prices, he will have some equity and he can refinance. And if he is unable to pay his mortgage, I will just put the house for sale. It is a rising market and I will make money reselling it, so this was really not any risk." Of course, we all know what happened, once housing price increases slowed down and housing prices eventually started to fall, then lots of borrowers and lenders got into trouble.

Secondly, a number of possible underlying causes were analysed using a more descriptive and qualitative approach. The aim here was to analyze if it had been possible to predict this credit crisis in 2007 by looking at the big five financial crisis in the developed economies and generally financial crisis in the past in order to see if they share the same similarity in terms of trend in their macro-economic fundamentals. We saw stunning qualitative and quantitative parallels across a number of standard financial crisis indicators. The run-up in U.S housing and equity prices which Kaminsky and Reinhart (1999) find to be the best leading indicators of crisis in countries experiencing large capital inflows closely follows the average of the previous eighteen post World war II banking crisis in industrial countries. So too, does the inverted v-shape of real growth in the previous years prior to the crisis. Despite widespread concern about the effects on national debt of the early 2000s tax cuts, the run-up in U.S public debts was actually below the average of other crisis episodes. In contrast, the pattern of United States current account deficits was markedly worse. In addition, majority of historical crises are preceded by financial liberalization as already documented in Kaminsky and Reinhart (1999). While in the case of the United States, there has been no striking de jure liberalization, there definitely has been a de facto liberalization.

Can we therefore say that the US subprime credit crisis was predictable and can be termed a predictable surprise? I say a big yes! Not only is the credit crisis a predictable surprise, it was surprisingly predictable. But that depends on what we mean by "predict". As it seems the vulnerability of the country to the crisis can indeed be detected. The mysterious question of what triggered the crisis was determined from our model. Could it have been that the vulnerability move closer and closer to a point in time where a crisis occurs, like a branch

under increased pressure that sooner or later it snaps? Or is it instead the case that vulnerability exists and some type of event sets off the crisis? We argue here for the former case and that the government should have seen this coming. This crisis did not take a different path when compared to other financial crisis in history.

The whole crisis episode can be likened to the probability of a risk of a fire occurring in a season of drought, but it is still the careless camper that sets it off. What is the careless camper in the Subprime? We say it is all the factors aforementioned in our model. At this juncture, we think that the vulnerability - the dry season that makes the forest highly flammable – can be easily sensed, and also the triggering factor -the careless camper (interest rate and housing prices) can also be detected if we have a regulatory body whose sole objective is to guide and educate the campers and also keep watch of the activity of the campers. By so doing, the regulatory body though might not be able to determine at exactly what time a careless camper would set it off, but at least it would have long detected the smoke before it turns into a full scale bush-fire.

Finally, I note that although this thesis has concentrated only on the United States, many of the parallels hold for other countries that began experiencing housing price duress during the 2007 which includes the United Kingdom, Spain and Ireland. This also provides another avenue for further research to see if our parsimonious model would be able to detect the probability of a crisis in 2008/9 for the aforementioned countries.

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APPENDIX

Table 1

```
logistic subprm pricechng intratechng

Logistic regression                               Number of obs   =         36
                                                  LR chi2(2)      =      11.37
                                                  Prob > chi2     =     0.0034
Log likelihood = -12.050972                       Pseudo R2       =     0.3204
```

subprm	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
pricechng	6.75e-37	2.40e-35	-2.34	0.019	3.35e-67	1.36e-06
intratechng	2882.551	10545.71	2.18	0.029	2.216586	3748602

```
Marginal effects after logistic
      y  = Pr(subprm) (predict)
         =  .10897011
```

variable	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]		X
pricec~g	-8.086713	3.86606	-2.09	0.036	-15.6641	-.509374	.028056
intrat~g	.7735056	.36958	2.09	0.036	.049147	1.49786	.011389

logistic: Predicted probabilities of positive outcome for **subprm**

Pricechng	Prediction
-.01	0.7443
0	0.5586
.01	0.3549
.02	0.1930
.03	0.0942
.04	0.0433
.05	0.0193
.07	0.0037

```
          pricechng  intratechng
x=       .02805556    .01138889
```

logistic: Predicted probabilities of positive outcome for **subprm**

intratechng	Prediction
-.39	0.0050
-.23	0.0176
-.19	0.0240
-.18	0.0259
-.17	0.0280
-.14	0.0353
-.13	0.0381
-.12	0.0412
-.03	0.0808
-.02	0.0870
-.01	0.0935
0	0.1005
.01	0.1079
.04	0.1332
.07	0.1632
.1	0.1985
.11	0.2115
.12	0.2251
.15	0.2695
.18	0.3191
.19	0.3366
.27	0.4897
.36	0.6628
.42	0.7602

```
          pricechng  intratechng
x=       .02805556    .01138889

.
```

Predictive Value of House Price change	Probability of a crisis
0.05	95% Conf. Interval Pr(y=1|x): 0.0193 [-0.0273, 0.0659] Pr(y=0|x): 0.9807 [0.9341, 1.0273] pricechng intratechng x= .05 .01138889
-0.15	95% Conf. Interval Pr(y=1|x): 1.0000 [1.0000, 1.0000] Pr(y=0|x): 0.0000 [-0.0000, 0.0000] pricechng intratechng x= -.15 .01138889

Predictive Value of **Interest rate change**	**Probability of a crisis**
0.05	95% Conf. Interval Pr(y=1|x): 0.1426 [-0.0018, 0.2871] Pr(y=0|x): 0.8574 [0.7129, 1.0018] pricechng intratechng x= .02805556 .05
0.75	95% Conf. Interval Pr(y=1|x): 0.9777 [0.8747, 1.0808] Pr(y=0|x): 0.0223 [-0.0808, 0.1253] pricechng intratechng x= .02805556 .75
-0.15	95% Conf. Interval Pr(y=1|x): 0.0327 [-0.0355, 0.1009] Pr(y=0|x): 0.9673 [0.8991, 1.0355] pricechng intratechng x= .02805556 -.15